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PROPOSED MEMORIAL CHURCH, ST. PETERSBURG, ON THE SPOT WHERE THE CZAR FELL.—T. GRAHAM JACKSON, M.A., ARCHITECT.

MEMORIAL CHURCH, ST. PETERSBURG.

LAST year the Municipality of St. Petersburg invited designs for a new church which they proposed to build over the spot where the late Czar Alexander II. was mortally wounded. Twenty-eight designs were submitted in reply to this appeal at the beginning of the present year, and the four premiums which were promised have been conferred on four Russian competitors. The design on our first page was submitted by Mr. T. G. Jackson. The plan is a Greek cross, with a central dome measuring 42 feet diameter, and wagon vaults over the four arms, and with three eastern apses. The arrangements are adapted to the somewhat inflexible requirements of the Russo Greek ritual, which differ in many respects from those of the other branches of the Eastern Church. The interior was designed to be lined with marble on the lower part of the walls, and mosaic above in the vaults and dome, and the details were modeled in the older and purer Byzantine style, which is, perhaps, less popular in Russia than either pure classic architecture or those peculiar modifications of Byzantine, of which examples may be seen in that part of Mr. Fergusson's "Handbook of Architecture" which relates to Russia.—*Building News.*

[Continued from SUPPLEMENT 344, page 5486.]

THE PANAMA CANAL.

By MANUEL EISSLER, M.E., of San Francisco, Cal.

II.

THE PANAMA RAILROAD.

OWING to the important role which this road is going to play in the building of the interoceanic canal, I will devote a few words to this enterprise, which, having been undertaken and carried out by North Americans, will be of so much more interest.

To many, especially Californians, this recital will bring forth remembrances of times when many among us came to these shores across Panama, in search of fame and fortune.

This railroad must be considered as the most useful in the world, because the same assures to the inhabitants of the western coast of the two Americas an easy communication with the Atlantic. The work of constructing the same did not commence seriously till 1850, and its success was only decided by a fortunate chance, by an event which saved the company at a moment, when, discouraged, the same was going to be abandoned Ever since 1835 the American Biddle had explored the isthmus with a view of studying a passage for a railway. At that time, Panama was completely in the decline—only a straggling village of five thousand inhabitants, asleep in their indolence and idleness. Of all those magnificent works of art, dating back to the old Spaniards (las Antiguas), of those fine paved roads, blazing in the sun, whose rays are reflected on the glittering pebbles, which wound around the town, and of which the principal one led to Porto Bello, nothing was left, hardly some mule trails in the valley of the Chagres.

Biddle followed the trail of the natives as far as Cruces, and from there reached Panama. Being a man of sound judgment and of practical intelligence, he understood on first sight the facilities which this passage offered in comparison to the routes he had formerly studied. Without taking more correct surveys, he went to Bogota to negotiate for a contract which assured to him concessions of land from the Colombian government. He then returned to the United States to organize a company, but died soon after reaching home.

In 1843, the French mining engineer, Mr. N. Garella, was engaged, as before mentioned. He studied the double project, canal and railroad. The events of 1848 led to the dissolution of this society, of which Mr. Joly de Sabla was president.

But that very year, 1848, saw the production of an event in the historical pages of the United States which made the construction of the Isthmus railroad an absolute necessity, namely, the discovery of gold in California

The war with Mexico had given us by the treaty of Guadalupe Hidalgo our magnificent California, and soon afterward two lines of steamers were established: one from New York and one from New Orleans to Chagres, the other from Panama to California and Oregon. At the same time enterprising men occupied themselves with the future railroad, but the work would have dragged along if the discovery of gold near Sutter's Mill had not brought to the isthmus a great multitude of miners, who were too much in haste to double Cape Horn.

Obliged to anchor in the offing of the Chagres, the vessels had to set sail at the least wind and to seek refuge in the Bay of Limon, bordered in many places by a shallow shore where they could not disembark. They had to await the good weather, return to the estuary of the Chagres, and land in the frail canoes of the natives, at the risk of capsizing on the bar; then came the sojourn, more or less prolonged, in the miserable huts of the port, exposed to the "Chagres fever," then an interminable journey in launches or canoes, against the current of the river, then again a long tramp through the forests.

This flock of passengers, this exodus, gave a vigorous impulse to the efforts of the society, and soon Messrs. Totten and Trautwine left New York with a number of workmen and material.

The operations were to have commenced at Gorgona, in the center of the Cordilleras, and were to descend on both sides toward the Pacific in one direction, and toward the Atlantic in the other.

They brought along two little steamers to be used on the Chagres River, but they were of no use to them, and they had to take to the bongos of the natives for means of transport on the river, but it proved too slow and expensive, and also were interfered constantly by the enormous transit which the passage of the gold seekers occasioned. This plan of building the road had therefore to be abandoned and the work was attacked on the Atlantic side.

This modified plan was put into execution in 1850. The hardest portion of the work in the swamps about the island of Manzanillo was inaugurated, and the workmen, after a hard day's work, had to return to the hull of a wrecked brigantine, and to the condemned steamer Telegraph.

Slowly more workmen commenced to arrive; from forty men, the force grew to one hundred. Gatun was reached toward the end of 1850, and the company was able to forward material and provisions to that point, and more men arrived to make the embankments, cuts, and lay rails.

But the astonishing news of California's riches continued to come, the fabulous stories of this immense wealth turned the heads of the laborers, and they abandoned their unhealthy trenches for the happy land of bountiful gold. The work of railroad building had to be abandoned.

Col. Totten and his worthy associates had to look for other workmen at Cartagena and the Antille Islands, and toward December they gathered about one thousand men together. In October, 1851, the provisory roadbed between Gatun and Colon was finished and the service established, and also a temporary dock constructed on the seashore at Colon.

Success was near at hand, but, unfortunately, the money had all been spent and the first million of dollars subscribed was gone. The value of the shares had fallen so low that a new subscription could not be counted upon.

By one of those providential circumstances, two steamers happened to come in at that critical moment into the port of Chagres, but could not disembark their passengers on account of a fearful hurricane. The next day was so stormy that the steamers could not hold to their anchorage, and had to take refuge in the Bay of Limon, near the island of Manzanillo, where they found calm waters. The emigrants there saw the gravel trains coming and going, and the idea struck them to mount them and gain in that manner Gatun, instead of waiting for the calm weather and mount the tortuous Chagres in those frail bongos. There was not a single passenger coach on the line, and more than a thousand men started on that memorable train for Gatun, and from there they reached Gorgona in bongos, and then went on foot or mule back to Panama.

This affair re-echoed throughout the United States, and the steamers abandoned the old anchorage ground of the dangerous bar at the mouth of the Chagres River, and anchored from that time on in the Bay of Limon, for discharging passengers and merchandise, which the railroad took from there to Gatun.

A small town sprang up out of these swamps, and was officially constituted in February, 1852, and named Aspinwall by the Americans, but the Spaniards named it Colon, in memory of the great navigator. The affairs of the company changed at once, money flowed into the treasury, and the work was pushed ahead and was gradually approaching the Pacific shores, to the great joy of the gold seekers who kept on coming.

A great drawback was therefore the lack of workmen, who, from 1850 to 1852, averaged from fifty to three hundred. As hardly had any of them earned enough to pay the passage to San Francisco, they deserted the work for the placers. In 1853, by recruiting in North and South America, in the Antille Islands, Europe, and China, a working force of six thousand men was got together.

In March, 1853, the road had reached Buhio Soldado, 24 kilometers from Colon; three months later, the same reached Barbacoas, 35 kilometers, and in January, 1854, the same got to the Cordilleras, at the pass of Culebra, 52 kilometers from the starting point. During that time the work was also started from the Pacific side, at Panama, the material being brought around Cape Horn to that point, and in January, 1855, the last spike was driven, and for the first time a locomotive, attached to a regular train, crossed the whole length of the isthmus, from Colon to Panama, marking an era in American history as to railroad building, it being the first transcontinental road on our great American continent.

The mortality which reduced the army of the workmen to a considerable extent, was nevertheless not so great as represented, and is used at present as a strong lever against the undertaking of the canal by its opponents and by the friends of other projects. But it must be borne in mind that during the building of the railway, the precautions in regard to a sanitary point of view were sadly neglected. There were no hospitals, no medical staff, nothing to protect the men in a strange, tropical country, exposed to malarial influences, with nobody to care for them in an entirely uninhabited country, a virgin forest; whereas now all along the whole line we find villages, farms, habitations, and comfortable dwellings, easy communications with the two ports, and everything to supply the wants and necessities of human beings—nothing spared in the way of food, nourishments, for the requirements of even the spoiled child of Parisian life and luxury. The conditions of now and then are different. The building of a railroad in 1850 was a greater task to the one of digging a canal in 1880. Such is the progress of our era.

The provisory Panama railroad was in time reconstructed and made solid by the building of an iron bridge at Barbacoas, 200 meters long, at Panama. The road was carried on a trestle bridge quite a distance out into the shallow bay. The roadbed was thoroughly ballasted with rocks from the quarry at Buhio Soldado, where the hard basaltic rock was broken into proper fragments in one of Blake's patented ore crushers or rock breakers. At Colon four wharves were constructed, where ocean steamers could come alongside to discharge cargoes and passengers. The slimy puddles of Colon were filled up, and improvements for a fresh water supply from neighboring springs improvised.

On leaving the main street of Colon, where four lines of railway occupy the whole breadth of the street, the same runs on an embankment for about one kilometer, then it crosses over a viaduct 200 meters long, which spans an arm of a lagoon, being a portion of the main bay of Colon, and named Puerto Escondido.

On reaching main land, the same is covered with mangroves, whose roots above ground, interlaced in all directions, form such an entanglement that it is impossible to penetrate into the forest, which is the home of splendid birds of all sorts of plumage.

At the end of about one kilometer, the road passes over hills of reddish clay, barren and sterile, a very rare thing in those climates. On the heights, however, the vegetation is grand, so bushy, so entangled with lianes, like a virgin forest, and one of them is chosen as the cemetery of Colon.

After crossing the Loma del Mono (Monkey Hill), a ridge of the Sierra Quebrancha, we enter the marshes of Mindi, green with Indian plants and papyrus, and then we follow from time to time the river, which is but a stagnant creek. Gradually the vegetation grows higher, the mangroves get taller, the palm trees more numerous; under the heavy plumage of their leaves fall the pendants of their bright flowers.

Two or three leagues from Colon, the line climbs some meters on the spurs of some abrupt hills, and a cut through the forest allows us for the first time to see the Chagres, wide and slow running. Very soon the river forms a big bend, which surrounds Gatun, a small village of straw huts on a flat plateau surrounded by undergrowth.

On leaving Gatun, the line crosses the river of the same name on a magnificent iron bridge, and enters the pass between Tiger and Lion Hills, two perfectly conical hills with steep sides, covered with magnificent banana plantations. Then we enter again into a marshy plain without mangroves, where high trees succeed to palm trees.

After passing the station of Aharca Lagarto, and near Buhio Soldado, the road enters into a gorge where the Chagres has made for itself a passage between the rocks. Up to the station of Buena Vista the road follows the banks of the river about 10 meters above the water, then cuts the plain of Frijole. At Barbacoas, near the station of San Pablo, the line crosses the Chagres on a fine bridge, then we reach a prairie, then a small forest with constantly changing fine scenery. We pass through several villages, like Mamei, La Gargona, Matachin, where the inhabitants occupy themselves with agriculture.

The road, on leaving the valley of the Chagres, enters the gorge of the Obispo and crosses two or three times this river, then the pass gets wider, and a second locomotive is attached to the train for the purpose of pulling the train up the slope of the Culebra, and, on reaching the summit, the locomotive is abandoned and we descend on the Pacific side.

We then follow a ravine where the road overhangs twenty meters above the torrent of the Rio Grande, then the valley gets wider and wider and the country more undulating.

The view becomes magnificent, the fine hill of Ancon standing out in profile against the azure blue heavens, and at his base extends Panama, overtowered by the Cerro de Cabras, and far beyond the fine bay, studded with green islands.

The descent brings us rapidly in the midst of a great plain. A small elevation of land, formed by the base of the Ancon hill, raises the roadbed above the marshes, where the sea spreads out at high tide. The forest reappears, but different from the flora of the Atlantic, and in every direction are thickets of cactuses.

We pass through the double row of straw huts of the suburb of Pueblo Nuevo, and a few minutes later the train enters the station of Plaza Prieta, the quarter of the city where the same is built in a curb made by the Gulf of Panama. The town of Panama has about fouteen thousand inhabitants.

After the destruction of old Panama by the pirate Morgan, the governor, Fernandez de Cordova, chose the present site on a high rock, forming a sort of peninsula, easily defended, on the base of the Cerro Ancon, as the site of new Panama. The celebrated engineer, Don Alfonso de Villa Carta, made a strong fort of it, surrounded by heavy, thick walls, several meters wide, and two strong bastions. All of that ancient grandeur is in ruins, and only one of the bastions is well preserved, and is used as a promenade, and on an evening I used to go there to enjoy the sea breeze, the only solace hot Panama has to offer to the stranger of northern climes.

PLOWING IN EGYPT.

WE give a sketch by an artist correspondent of the *Illustrated London News*, drawn recently from life, showing a native farmer at work, and presenting a fair idea of the status of agriculture as now practiced in modern Egypt. It will be seen that the same antique plow of bent sticks, that was used in the time of Moses, is still employed, and that modern improvements have gained no foothold. What this picture reveals in respect to agriculture is typical of the present condition of almost every other branch of Egyptian industry. Little or no progress has been made; but everything is done in the same manner that it was performed centuries ago. "The way in which our ancestors lived and worked is the path for us to follow," says the Egyptian of to-day. His mind, like a true machine, has no tendency to deviate from the direction in which it originally started. It remains to be seen whether the late tremendous thunderings of the British iron-clads will have any rousing effect upon Egyptian lethargy, or whether the nation will continue to live the life of the past.

RECENT PROGRESS IN AGRICULTURAL SCIENCE.

By H. P. ARMSBY.

ASSIMILATION.

IN its strict sense, assimilation in plants means the process of forming new organic matter out of inorganic materials by the aid of the sun's rays, and is peculiar to chlorophyl-bearing plants. It will be convenient, however, to give the term a somewhat more extended meaning, and to apply it not only to this process, but also to those related processes which furnish the materials for true assimilation, and to consider in the same connection the kinds and sources of these materials.

Essential Elements.—The question what elements are necessary for the growth of the higher plants may be considered as practically settled. A few points may, however, be noted in passing. As is well known, the earlier experiments showed potassium to be one of the elements essential to plant growth, and it was natural that the question should arise whether the functions of this element in the plant could not be performed by other of the alkali metals. Experiments with sodium showed that this element was incapable of taking the place of potassium, and Nobbe has shown that lithium acts as a direct poison to plants. The physiological worth of these three elements increases with their atomic weight; may it not be possible that other elements of the same group having a higher atomic weight may have a still higher worth? An answer to this question has been attempted by Loew,* in some water-culture experiments on buckwheat with rubidium. Earlier experiments by Birner and Lucanus with rubidium, gave very unfavorable results, but according to Loew, the abnormal appearances in their plants were exactly those observed by Nobbe to result from the absence of chlorine; and as only rubidium nitrate was used, it was thought desirable to make similar experiments with the chloride, as well as to repeat those with the nitrate.

The latter gave an entirely negative result; but the experiments with the chloride, in comparison with potassium chloride, though not fully successful, seem to show that at least a certain amount of growth may be made by the aid of rubidium. Still better results were obtained in a third experiment, in which a much smaller amount of rubidium was used, in the form of nitrate, with the addition of ammonium chloride. In both experiments the plants grew well until the time of fruiting, and from then on fell behind the potassium plant. The plant nourished with rubidium chloride formed no seeds, and that fed with the nitrate only one; but whether this was due to abnormal nutrition or to some other cause, does not clearly appear. On the whole the results, though not conclusive, seem to indicate the *possibility* that suitable quantities of rubidium in a properly constituted solution may be able to take the place of potassium.

Silica in Plants.—Another old question which has lately received renewed attention, is that of the necessity or utility of silica to the plant. As regards its necessity, the newer experiments have only confirmed the results of the older ones that silica is entirely non-essential. A somewhat striking proof of this has been given by Höhnel † The pericarp of *Litho-*

* Landw. Versuchs-Stationen, 21, 389.

† Haberlandt's Wiss. prakt. Untersuchungen, 2, 160.

spermum arvense is normally very rich in silica, containing from 13 to 16 per cent. of this substance, while its outermost layers contain probably 70 per cent. Höhnel has, however, succeeded in producing, by means of water culture, ripe seeds of this plant containing at most but minute traces of silica.

It appears, however, from recent experiments, that silica, though not essential to the plant, is nevertheless serviceable to it. In Hohnel's experiments it was noticed that the plants grown without silica suffered from plant lice, while neighboring plants which received silica were not thus affected.

Some experiments by Wolff show that silica has more important functions than the simple protection of the plant. Experiments on the growth of the oat plant in aqueous solutions,* continued through fourteen years, have led him to the conclusion that silica favors the easonable and uniform ripening of the grain by causing the death of the leaves at the proper time, which is followed by a translocation of the nutritive matters contained in them to the seeds. Thus in an experiment without silica, 30 seeds were produced, with a little silica 90, and with much silica 184. Another function of silica was also revealed in some of these same experiments. The experiments were directed toward ascertaining the minimum amount of the several ash ingredients necessary for the production of an average crop.† Thus it was found that the amount of potash could be reduced to about 0·8 per cent. of the dry weight of the plant, that of phosphoric acid to about 0.5 per cent. etc., etc. It was found impossible however to produce a single plant which contained *all* the ash ingredients in the minimum quantity. The total ash, it was found, must always be considerably in excess of the sum of the minima of each ingredient. Only when some indifferent mineral substance, like silica, was supplied to the plants, could a normal growth be obtained with the minimum amounts of the other ingredients. The *role* of silica in this respect can also be assumed by lime or by phosphoric acid; but these substances, especially the latter, are somewhat costly, while silica is present in an assimilable form in all soils in greater or less quantity. It would thus appear that while silica is not essential to the *plant*, it may be of great importance to the *crop* by enabling it to make a satisfactory growth in a soil which, without the silica, would not furnish a sufficient supply of ash ingredients, or by preventing a useless consumption of phosphoric acid or other ash ingredients, and an unnecessary exhaustion of the land.

Sources of Plant Food.—That the *carbon* of vegetation is chiefly supplied by the carbon dioxide of the atmosphere has become one of the truisms of botany; but the question whether this is the sole source of the carbon of agricultural plants and crops, or whether the numerous carbon compounds existing in most fertile soils contribute to any considerable extent to their nourishment is one that has given rise to no little discussion. The well-known experiments of De Saussure and others (compare Johnson's "How Crops Feed," p. 232 *et seq.*) render it extremely probable that the organic matters ("humus") of the soil, may be assimilated by plants, as we know that certain nitrogenous organic matters may be.

* Jahresber. Agr. Chem. N. F., 3, 216.
† *Ibid.*, 18-19, 1, 250

Some later experiments point in the same direction. Van Tieghem* finds that the embryo of *Mirabilis jalappa* will grow when the endosperm is reduced and replaced by a paste of albumen and water, or of potato starch and water, containing the necessary inorganic nutriments. By microscopical examination and otherwise, Van Tieghem satisfied himself that these substances were actually assimilated, From the brief account of these experiments accessible to the writer, it is impossible to judge of their accuracy or of the weight which is to be given them, and Böhm† on repeating them obtained negative results; but Blociszewski‡ has since repeated and extended them with much the same result as Van Tieghem. Embryos of rye and peas, separated from the endosperm or cotyledons, assimilated starch and sugar, and grew, not indeed as well as those of whole seeds, but decidedly better than those which received no artificial food. The starch grains which lie next to the scutellum of the rye or the epidermis of the radicle of the pea were found to have been attacked and almost entirely dissolved. Embryos of rye also grew when nourished with their own finely ground endosperm, while embryos of the pea grew no better when embedded in pellets of their own ground cotyledons than without this addition. The pea embryos, on the other hand, seemed to be aided in their growth by a dilute solution of asparagin, while this substance appeared to be of no use, or even harmful, to the rye embryos.

It thus appears that plants may assimilate "organic" matter not only when full grown, but also in the first stages of their existence.

A few trials have been made by Stutzer§ to ascertain what classes of organic substances may be assimilated. He experimented chiefly on young plants of *Brassica rapa*, growing them in an artificial soil composed of sand or pumice stone and calcium oxalate or tartrate, moistened with a solution of the needful inorganic ingredients. The plants were placed under bell-glasses, from which the carbon dioxide of the air was excluded. They grew vigorously and gained as much as 228 per cent. of dry matter, thus showing that these acids served in some way as a source of carbon. It was possible, however, that they were first oxidized in the plant to CO_2, which was then assimilated, and to test this a second series of experiments was made in the same way, except that a dish of concentrated solution of sodium hydrate was placed inside each bell glass. Under these circumstances the plants cultivated in the calcium oxalate speedily died, and showed a loss of 4 to 7 per cent. of their dry weight in ten or twelve days, thus showing that the oxalic acid could not be utilized as such by the plant, but must first be oxidized to CO_2. The calcium oxalate remaining after these experiments contained notable quantities of carbonates. The plants cultivated in the calcium tartrate, however, behaved differently. Here a growth took place, and an increase in the dry weight of 66 and 69 per cent. in seventeen days was obtained.

* Jahresber. Agr. Chem., 16-17, 1, 259.
† Landw. Jahrbuecher, 5, 145.
‡ Jahresber. Agr. Chem., 18-19, 1, 247.
§ Landw. Versuchs-Stationen, 21,193.

Other plants, cultivated in the same soil but with only the atmospheric CO_2 excluded, gained fully twice as much in the same time. In all cases he roots were found incrusted with calcium carbonate. This formation of calcium carbonate, Stutzer suggests, may be explained as due to a metathetical reaction between the soluble carbonates of the roots and the oxalate or tartrate of the soil. The different behavior of oxalic and tartaric acid in these experiments Stutzer explains by a reference to their chemical constitution. Oxalic acid consists of two carboxyl groups, from which, apparently, the plant is unable to appropriate carbon directly. Tartaric acid, on the other hand, contains two carboxyl and two alcoholic groups, and from the latter, according to Stutzer, the plant can assimilate carbon without the necessity of a previous oxidation to CO_2. When the plants were cultivated in a bell-jar containing sodium hydrate, only half the carbon of the tartaric acid could be utilized, and a large amount of CO_2 was found in the sodium hydrate solution at the close of the experiment. In the case in which the sodium hydrate was omitted, however, the carbon of the carboxyl groups was also available, being first oxidized to CO_2 and exhaled, and then assimilated by the chlorophyl grains. Hence, the growth in the latter case was about twice as great as in the former, corresponding roughly to the greater amount of assimilable carbon at the disposal of the plant. A confirmation of this hypothesis was given by an experiment in which glycerine was the sole source of carbon. A gain of 126 per cent. of dry substance was made in seventeen days.

As numerous difficulties had to be overcome in experiments of this sort on higher plants, the investigation was continued with chlorophyl-free plants, chiefly with *Penicillium glaucum*, in which, if growth took place at all, it must be at the expense of the "organic" carbon. It was found that oxalic and formic acids, that is, acids containing only carboxyl groups, were incapable of nourishing this plant. Acetic acid and acetates produced an abundant growth, as did also succinic acid. Succinate of iron was also found capable of furnishing carbon to plants of *Brassica rapa* in an atmosphere free from CO_2. Ethyl, alcohol, glycerin, sugar, malic acid, citric acid, lactic acid, and tartaric acid caused an abundant growth of the fungus, as, according to Stutzer's hypothesis, they should do; but butyric acid, valerianic acid, and amyl alcohol formed noteworthy exceptions, neither sustaining *penicillium* themselves nor permitting its growth in solutions to which glycerin or sugar had been added.

Stutzer's experiments have been repeated by Schmöger,* who obtained similar results, but does not regard them as conclusive, since, according to his experiments, the method adopted includes a grave source of error. This source of error lies in the fact that both oxalate and tartrate of calcium are very easily decomposed by the action of bacteria or other organisms into calcium carbonate and carbon dioxide, so that the soil in Stutzer's experiments was a continual source of CO_2. Schmöger found that moist mixtures of

* Jour. f. Landw., 28, 179.

EGYPT AS IT IS: PLOWING IN LOWER EGYPT.

calcium oxalate or tartrate with solution of plant food and with sand (the latter may be omitted) contained, after being exposed to the air for some twenty days, very considerable quantities of calcium carbonate and an abundance of bacteria resembling *Bacterium termo*. Similar mixtures were placed in two flasks, heated to boiling on the water-bath, and stoppered with cotton heated to 120°. Two other flasks were filled in the same way, but not heated. One of each pair was opened after twenty days. The contents of the boiled flask contained no CO_2, those of the unboiled flask 0·234 gramme. After thirty-four days the other boiled flask contained no CO_2, and the other unboiled one 0·2675 gramme. Schmöger also determined the amount of CO_2 absorbed by the potash solution in his vegetation experiments, as well as the combined CO_2 remaining in the soil, and found the two to be approximately equal. In experiments with plants grown in sand alone, the amount of CO_2 exhaled was found to be very small. Schmöger, therefore, concludes that the growth obtained by Stutzer and himself in those experiments in which no potash was present was made by means of the CO_2 exhaled by the artificial soil, and that it is very possible that the small growth obtained in the presence of potash was due to small portions of CO_2 which escaped absorption. At any rate, in the absence of proof that the experiments were really made in an atmosphere free from CO_2, they furnish no evidence of a direct assimilation of organic carbon compounds by the higher plants.

Experiments with such organic matters as are found in the soil have in general given negative results. Detmer* claims to have observed microscopically an absorption of some of the oxidation products of humus (crenic or apocrenic acids) by the rootlets of young peas, and thinks it probable that they contributed to the nourishment of the plants.

Böhm† has sought to solve the question by investigating whether bean plants, freed from starch by long vegetation in the dark, could produce starch when supplied with carbon only through their roots. Negative results were obtained in all cases. No starch formation could be detected, and plants grown in a garden soil containing humus lived no longer than those grown in pure sand (with addition of inorganic nutrients).

Moll‡ has made similar experiments and obtained the same result. In no case was the least formation of starch observed, but on the contrary, starch disappeared from leaves containing it when they were placed in an atmosphere free from CO_2, although they remained in connection with the plant, which grew in a moist soil rich in humus, and presumably containing much CO_2. Leaves were also separated from the plants, and arranged with the basal end in an atmosphere containing about 5 per cent. of CO_2, while the upper end was in an atmosphere kept free from this gas. In some cases an intermediate portion of the leaf was exposed to the air, and in others not. The leaves having been made starch-free in the first place, not the least formation of starch could be detected in the portion of the leaf deprived of CO_2, although it took place vigorously in the other portion of the leaf. Comparative experiments were also made on the rapidity of starch formation in starch-free leaves. A leaf was divided lengthwise just at one side of the midrib. One portion was freely exposed to the air, while the base of the portion containing the midrib was surrounded with an atmosphere containing 5·5 per cent. of CO_2. It was found that this abundant supply of CO_2 to the lower end of the leaf was unable to accelerate at all the starch formation, but that the latter went on at sensibly the same rate as in the other half of the leaf. It was likewise found that the CO_2 of the soil was equally unable to accelerate the formation of starch in the leaves. It would, therefore, appear that CO_2 cannot be transferred as such in the plant, even through very short distances, and also that the organic matter in the soils used by Moll was not able to contribute appreciably to the nourishment of the plants. Corenwinder,§ however, has observed that the leaves of a branch of a young chestnut tree, which was inclosed in an atmosphere free from carbonic acid but not severed from the tree, developed normally, from which fact he concludes that they were nourished by carbonic acid dissolved in the sap. Moll's results certainly throw serious doubt on this conclusion, and it is quite as reasonable to suppose that a transfer of plastic materials from the remainder of the tree took place.

The experiments of Böhm and Moll, as well as the very similar ones of Cailletet,‖ while they do not conclusively show that plants may not assimilate carbon from organic compounds, do show that under ordinary circumstances and in ordinary soils the amount of carbon which plants obtain through their roots is at least too small to be of any practical significance. The undoubted value of the humus of the soil and of manures lies partly in the inorganic matters which it contains, but to a far larger degree in the solvent action of the carbonic acid generated by its decay, and in its influence on the physical properties of the soil.—*Amer. Chem. Journal.*

RHEA.¶

By J. R. ROYLE.

THE fiber known under the various commercial names of rhea, ramie, and China grass, is one that has, of late years, attracted considerable attention, owing to the rewards which were offered by the Government of India for the best machine or process adapted for stripping the fibrous envelope of this nettle from the stems, and for freeing it from the gummy matter with which it is highly charged.

Efforts to encourage the production of this plant in India were commenced early in the present century, when Dr. Roxburgh obtained a few plants of a species of *Urtica*, which he named *Urtica tenacissima* (on account of the great strength of its fiber), from Sumatra, and from these a great number of plants were reared at the Hon. Company's Botanical Garden at Seebpore. The first fiber from these plants was sent to England in 1810, and was very favorably reported on as a cordage material, on account of its exceeding strength; owing, however, to the lack of suitable machinery for its preparation, no further efforts worth mentioning were made for some years. In 1840, Colonel Jenkins discovered the plant growing wild in Assam, and it had, even before this date, been found to be identical with one grown in the Rungpore and Dinagepore districts, under the name of khonkhoora. Not long afterward, Dr. Falconer and Sir Wm. Hooker were able to identify this *Urtica*, khonkhoora, or rhea, as the same plant as that from which the Chinese grass-cloth was made, and in 1854, the Court of Directors, in forwarding to India a memorandum on the fiber, by Dr. Forbes Royle, directed the purchase of ten tons of rhea fiber annually, for three years, in order to encourage its cultivation. After this, the fiber being well-known in England, it was considered that its further development might be left to private enterprise; events, however, proved that the obstacles to the development of its commercial use had not yet been removed.

In 1869, the Government of India took the matter up, and after obtaining all the information that could be furnished by the Agri-Horticultural Societies in India; and by gentlemen who had been for years engaged in experiments with rhea, came to the conclusion that all the conditions necessary for its cultivation in India on a large scale existed, and that all that was wanted was some machine or process suitable for separating the fiber from the stems and bark of the plant in its green state. They, therefore, issued a notification offering prizes of £5,000 and £2,000 for the two best machines, the merits of which were to be tested in India, the principal condition being that fiber worth £50 per ton in the English market, should be produced at a cost not exceeding £15 per ton in India. The trials were eventually fixed to take place in April, 1872, at Sahâranpur, and a plantation of rhea was there established in order that the necessary raw material might be obtainable on the spot. No less than 32 competitors entered for the trials, but at last only one—Mr. Greig—put in an appearance. Mr. Greig's machine was duly tried, but the cost of preparing clean fiber by it was found to exceed the stipulated £15 per ton, while the samples of fiber prepared were valued in London at only £28, and declared fit only for cordage purposes. This being the case, it was impossible to award the full amount of the prize to the inventor, but he received £1,500 in recognition of the merits of the machine.

During the next few years, Dr. Forbes Watson—whose name will always be associated with the attempts to bring rhea into use in manufactures—exerted himself with great energy and success in this country in endeavoring to make the fiber more generally known, and he was fortunate in obtaining a supply of China grass seed, as well as of green stems, which were advertised under the authority of the Secretary of State for India, and distributed to all applicants who were willing either to try to grow the plant or to experiment on the stems. In 1875, Dr. Forbes Watson pointed out the extreme difficulty of inducing any large number of competitors to incur the expense of taking their machines to India in order to compete for a prize, and suggested that trials should be held in this country instead. It was, therefore, at last determined that experiments should be made in London, both with green stems grown in Europe, and with dried stems procured from India, and it was hoped that everything would have been ready for the trials by November, 1875. Several inventors entered their machines for competition, although no prize was offered; but, unfortunately, owing to unforeseen difficulties, it was found impossible to hold the proposed trials.

This being the case, the Government of India, in 1877, issued a new notification, in which, after referring to the prize offered in 1869, and to the fact that the only machine brought forward to compete for it was not considered entitled to the full reward, and had not since been adapted by the inventor to practical use, they proceeded to state that the demand for rhea still continued, and that the conditions which induced the Government at that time to offer a prize remained substantially unchanged. They, therefore, again offered a prize of 50,000 rs. to the inventor of the best, and 10,000 rs. to the inventor of the second best machine or process for preparing rhea fiber; the machine or process to be capable of producing, by animal, water, or steam power, fiber of an average value of not less than £45 per ton in the English market, at a total cost of not more than £15 per ton, laid down at any port of shipment in India, or £30 per ton in England, after payment of all charges usual in trade. The competition for these prizes was fixed to take place at Sahâranpur, in August or September, 1879, and it eventually took place in September and October of that year. As many as 24 applications for permission to compete were received, but only 10 competitors finally arrived at Sahâranpur, and 3 of these withdrew before the commencement of the trials, leaving 7, viz., M. Van der Ploeg, M. Nagoua, Dr. Collyer, Messrs. Labérie and Berthet, Mr. Cameron, Mr. Amery, and Mr. Blechynden, to compete for the prizes. The fibers prepared by each of the competitors were carefully packed and sent to London for valuing, with the result that none of them were valued at anything like the stipulated £45 per ton; the highest value, indeed, affixed to any of the samples by Messrs. Noble & Co., was £26 per ton. Messrs. Mark Dawson & Son also examined the specimens of fiber, and reported very unfavorably on them, saying that even the best were a long way from being equal to the fiber imported from China. But they offered to pay £25 per ton for one or two tons like some of the best samples, in order that they might put it through all their various processes of manufacture, and see what it was worth. At this time China grass was selling at £50 per ton in the English market.

On receipt of these unfavorable reports, the Government of India felt themselves unable to award the prizes which had been offered; but they made awards of 5,000 rs. each to Messrs. Van der Ploeg and Nagoua, and of 1,000 rs. to Mr. Cameron, the competitors whose samples were considered the best by the English experts. Judging from the reports on the samples, the Government of India came to the conclusion that it did not seem probable that India rhea fiber would be able, at present, to compete successfully with the Chinese product, and that in most parts of India the cultivation of the plant could not be undertaken with profit. They considered that the soil and conditions of climate might be found suitable in parts of Burmah, Upper Assam, and in some districts of Eastern and Northern Bengal; and that if it could be grown in such places, with no more care than is required for a superior crop in an ordinary well-farmed field, it might possibly succeed commercially. They were, however, of opinion that it would be inadvisable to renew the offer of a prize for a suitable machine until such time as private enterprise should have shown that the cultivation of the rhea plant could be undertaken with profit in India, and that there was real need for an improved method of preparing the fiber. Intending growers of the plant can, however, still be provided with roots from the Botanical Gardens at Howrah, for the purpose of starting their plantations.

Here, then, for the present, at least, the matter of the utilization of Indian-grown rhea rests, so far as government action is concerned, but private individuals are still diligently working, and will, it is to be hoped, continue to work until the problem of putting an Indian-grown rhea fiber into the market at a price and of a quality which will compete with China grass is solved. Other countries appear to be succeeding in pushing the fibers in which they are interested; for instance, the Dutch have lately been sending over consignments of prepared ramie fiber from Java to the Continent, and some bales have lately reached the English market, where they are stated—although not very well cleaned—to compare not unfavorably with China grass. I have not, however, been able to ascertain by what process this Java fiber is prepared.

In Réunion, a French naval surgeon (M. Renaud) has found a process for easily and rapidly preparing the fiber, by means of an alkaline bath, the strength of which is to be tested by Gay Lussac's densimeter, in order to avoid its being so strong as to weaken the fiber; and in Paris, Messrs. Labérie and Berthet have patented a machine which they have worked for some time, and which is said to prepare about 800 kilogrammes of fiber from green stems per day of ten hours. In America, Messrs. Dennis and Angell have patented a machine which is said to be capable of thoroughly and rapidly preparing the fiber from ramie stems, although it was originally designed for jute. According to the most recent advices, this machine has not yet been perfected, and the inventors purpose carrying out some experiments during the coming summer, with a view to its improvement.

Incidentally, it may be mentioned that, in the course of his experiments, M. Renaud claims to have discovered that the planting of rhea among vines protects the latter from the attacks of the *phylloxera*, and even cures those which are already attacked by that dreaded pest. If events should bear out the correctness of this claim, a great boon will have been conferred on vine growers.

In England, numerous experimentalists—some tempted solely by the hope of gaining the Indian prizes, and others, induced by an honest wish to make a valuable fiber more suitable for use by manufactures, and to add another to the list of useful substances with which India supplies Europe—have, for years, been expending money and time and energy, in the endeavor to perfect some machine or process for preparing this fiber for market; but it cannot be said that, as yet, any one has been entirely successful, though many processes have appeared to act remarkably well with small experimental lots of stems.

Time would not suffice, on the present occasion, to give anything like a complete list of all the experimentalists, but, generally speaking, it would appear that those who have adopted the simplest machinery, or processes, have produced the most satisfactory results. Among others who have devoted a great deal of time to the solution of the problem, I may mention that Mr. Sebastian Anderson has succeeded in producing some very excellent samples, in which the separate filaments of the fiber are all as parallel to one another as they were in the original stems. He has not communicated the details of his process to me; but he tells me that he can, with perfect ease, separate the bark and gum from the fiber of either green or dry stems; after stripping the bark and fiber from the stems by hand, he soaks the strip thus removed in a bath, which, while in no way weakening the fiber, thoroughly removes every particle of bark and gum. He has informed me that he is endeavoring to make arrangements for the carrying out of his process in India, and for the transmission of the prepared fiber to London for sale. It is to be hoped that Mr. Anderson's efforts may be crowned with success, but it is worth considering whether, seeing what a continued demand there is for the fiber which comes from China, and which is all hand-prepared, the first endeavor should not be to imitate as closely as possible the Chinese hand-process—notwithstanding its slowness—and to try to forward from India supplies of hand-prepared fiber of as good a quality as the Chinese. There does not seem to be any insurmountable obstacle in this direction, neither does there seem any reason why the fiber could not be grown and prepared as cheaply in India as in China. Above all things, it is to be hoped that experimentalists will not be discouraged by the results of the trials held at Sahâranpur, in 1879, and that they will not assume that, because the samples of fiber sent to England as the result of those trials were all inferior, both as regards quality and as regards their mode of preparation, therefore India is incapable of growing fiber of good quality, if only she is shown how to prepare it for market.

The proprietors of the Jugdespore estate, in the Shahabad district of the Patna division of Bengal—the estate or zemindary referred to in Mr. Mylne's interesting paper, which was read before this society last month—thinking it probable that the Indian rhea problem is more likely of solution as a domestic industry than by means of centralized machinery, have been making experiments in that direction, in the cultivation of the plant and hand preparation of the fiber; the results of the former are satisfactory, and the latter has to be introduced into the homes of the people as a new industry. It has been ascertained by experiment that if the green stems are stripped by hand of their envelope of bark and fiber as soon as they are cut, and if the strips are allowed to simmer for a short time in a weak solution of potash, the bark and gum can, with the greatest ease, be scraped or rubbed off from the fiber. Mr. Mylne and his partners propose that this part of the work shall be done mainly by women and children, who will thus be enabled to earn a little money in their own homes; if this part of the scheme succeeds, a great point will have been gained, seeing that the difficulty of finding domestic employment suited to the poorer native women of high caste, who are not permitted to work in the fields, is well known.

The proportion of potash which has been found, after several experiments, to be the best, is about 2½ lb., to every 100 lb. of green strips of bark; and the length of time for simmering varies from two to three hours. Some samples of rhea fiber, prepared by this process by natives in India, have been sent over to England, and valued by brokers at £40 a ton, at a time when China grass was at £48; this is a proof of the success of the hand process, and it also appears that the potash bath when of the proper strength does not weaken the fiber; for some dry bark has been left to soak in the mixture for from ten to fifteen days, after which time the fiber was found to have lost none of its original strength. It is probable that, before long, some inexpensive mechanical adaption may be found, which will supplement or assist the hand process; and with this view, Mr. Mylne is experimenting with some simple machinery, which he believes will enable the women to separate the fiber from the bark much more rapidly.

If these efforts are successful, they will have the effect not only of creating a new domestic industry in many parts of India, but also of bringing into the English market a fiber which will be more thoroughly cleaned, and at a lower price, than heretofore; when this has been done, it will be suitable for a far wider range of manufactured goods than at present. Owing to its scarcity, and consequent high price, rhea of good quality can now only be used to replace, or mix with, silk or wool; but if only the price would

* Jahresber. Agr. Chem., 13-15, 2 166.

† Landw. Jahrbucher, 6, 327.

‡ *Ibid.*, 18-19, 1, 247.

§ Jahresber. Agr. Chem., 18-19, 1, 299.

‖ Jahresber. Agr. Chem., 13-15, 2, 166.

¶ From a paper lately read before the Society of Arts, London.

allow, it would be at once found suitable also for use in that far larger class of goods in which flax is now used. It may be safely asserted that cheapness of production and cleanness of fiber are the only two points which need attention in order to create an almost endless demand in this country for Indian rhea fiber; for although there are still certain mechanical difficulties in the manipulation of the fiber in the processes of manufacture, these are not insuperable.

Within the last days I have had an opportunity of seeing at work in London a machine patented by M. Roguet, in which dry rhea stems have been tried; some of the samples produced are shown here this evening, and it will be observed that they are not very free from bark; but it is to be hoped that further experiments may show an improvement in this respect.

It is to be regretted that statistics are not available to show the actual amount of China grass imported into this country during the last few years. Messrs. Manning and Collyer state that, in 1872, about 139 tons were imported, but that since that time the consumption has fallen off very materially, and that for the last ten years the average has probably been not much more than 50 tons, or certainly below 100 tons per annum; this small consumption is, however, merely due to the small amount of fiber which comes into the market, and its present high price.

Messrs. Mark Dawson & Sons have kindly sent me a few specimens of the applications of China grass to manufactures, and these, as well as some specimens of Indian grown rhea, prepared by different processes, are now shown here.

The first idea which occurs to one, after a survey of these new trade productions of India, which have in a few years become of such great importance, is, that they afford another proof of the immense latent productive force of India, in fact, they show us that when at last, after many patient efforts, any new Indian product has been introduced into the markets of the world, the trade in it is likely to quickly assume vast proportions. India abounds in vegetable products, which are capable of being put to endless uses in modern manufactures, if only they can once be properly got at; while the country seems capable of raising, not only those vegetable productions which are indigenous to it, but also those of nearly every other country of the tropical and sub-tropical zones.

WHITE CEDAR.

Among the interesting resinous trees of the United States, the white cedar is quite prominent, on account of the varied uses of its wood. The locality of its growth is confined, says the *N. W. Lumberman*, to a limited region along the Atlantic coast, between New York and Savannah, extending back from the coast no greater distance than 50 miles. At New York, and in Pennsylvania and New Jersey, it is known by the name of white cedar, while in Maryland, Virginia, and North Carolina, it is known as juniper. The tree belongs to a different genus from the junipers. The names somehow get displaced and wrongly applied. In Vermont, New Hampshire, and Massachusetts, and the more northern parts of America, the *arbor vitæ* is called white cedar.

This tree grows only in wet grounds. In tracts near the ocean in New Jersey, Maryland, and Virginia, it occupies a considerable portion of the extensive wharves which are near what is termed the salt meadows, exposed to the overflow of high tides. The interior swamps of New Jersey are almost exclusively occupied by white cedar. It is 70 to 80 feet in height, and sometimes more than three feet in diameter. Where the trees grow in close proximity, the trunk is straight and perpendicular, and has no branches for 50 or 60 feet. On the young trees the epidermis is very thin, but afterward it becomes thick, of a soft, filaceous texture, and of a reddish color. When cut it exudes a yellow transparent resin of an agreeable odor, but very scanty. The foliage is evergreen. Each leaf is a little branch numerously subdivided, and composed of small, acute, imbricated scales, on the back of which is a very minute gland, hardly visible to the eye without the aid of a lens. In the angle of these ramifications the flowers grow, which open in April or May, and are scarcely visible. These produce very small, rugged cones of a greenish tint, that change to a bluish color toward autumn, when they open and release the fine seeds. The wood is light, soft, fine-grained, and easily worked. When the lumber is exposed to the light and air for some time it becomes reddish, and sometimes of a dull rosy hue. Kept in a dry place, it retains the nuturally strong, aromatic odor almost indefinitely. The perfect wood resists remarkably well the successions of dryness and moisture, and on this account, as well as its remarkable lightness, it is highly prized for shingles, which last from 40 to 50 years. Large quantities are manufactured at Norfolk, Va., the wood being obtained in great abundance from the Dismal Swamp, which abounds in white cedar. Six or eight millions of these shingles are used by the trade in New York city, about the same in Philadelphia, and a less quantity in Boston and Baltimore. Before the war the shingles were split out, and shaved by hand in a slow and laborious manner. They are now made by machinery in large quantities, and besides being extensively used here, are shipped to the West Indies, but not in very large quantities.

A large business is done in white cedar railroad ties. The wood is excellent for this purpose, where resistance to decay is required rather than durability under heavy pressure. Under the weight of heavy trains the cedar wears rapidly, but on roads where there are mostly light passenger trains it is found that these ties are superior, as they stand any climate well and are not attacked by insects. A. T. Stewart's Garden City railroad, built ten years ago with cedar ties, is in fair condition yet, although few ties have been replaced since the construction of the road. Oak ties, in the same time, would have largely gone to decay. About 300,000 of these ties are distributed annually from New York, Philadelphia, and Boston. They are used somewhat extensively in Cuba and Central America.

This cedar is also used for telegraph poles in and around the vicinity of its growth. It is used now almost exclusively for cross-arms. It is the best possible material for the purpose, being strong, durable, and light. Lightness is a desirable consideration, especially to the men who have to "pack" the cross-arms up the high poles. The wood is nearly as strong as pine, and much more durable. After persistent and long continued efforts, John L. Roper & Co., of Norfolk, Va., secured the attention, and later the contract, of the Western Union Telegraph Company, and now these cross-arms are to be seen all over the country, wherever this company has a line. The Mutual Union and American Rapid Companies are also using them.

There are 2,000,000 or 3,000,000 feet consumed annually in lumber, being used in making tanks and boats. Many brewers prefer the wood for tanks. It is quite a favorite with some in boat building, and it is exported in limited quantities to England for this purpose.

Years ago the superior qualities of the wood for making the various household utensils induced parties in Philadelphia to have a separate class of manufacture, and the mechanics were called cedar coopers. No less than 1,000 cords of the wood are used every month at the present time, and large quantities of goods are manufactured for the domestic and foreign market. Pails, wash-tubs, and churns are the principal articles, although others are common. The ware is light, cheap, and easily made, and instead of becoming dull, like most woods, it improves by use. It is used by some piano manufacturers for sounding boards.

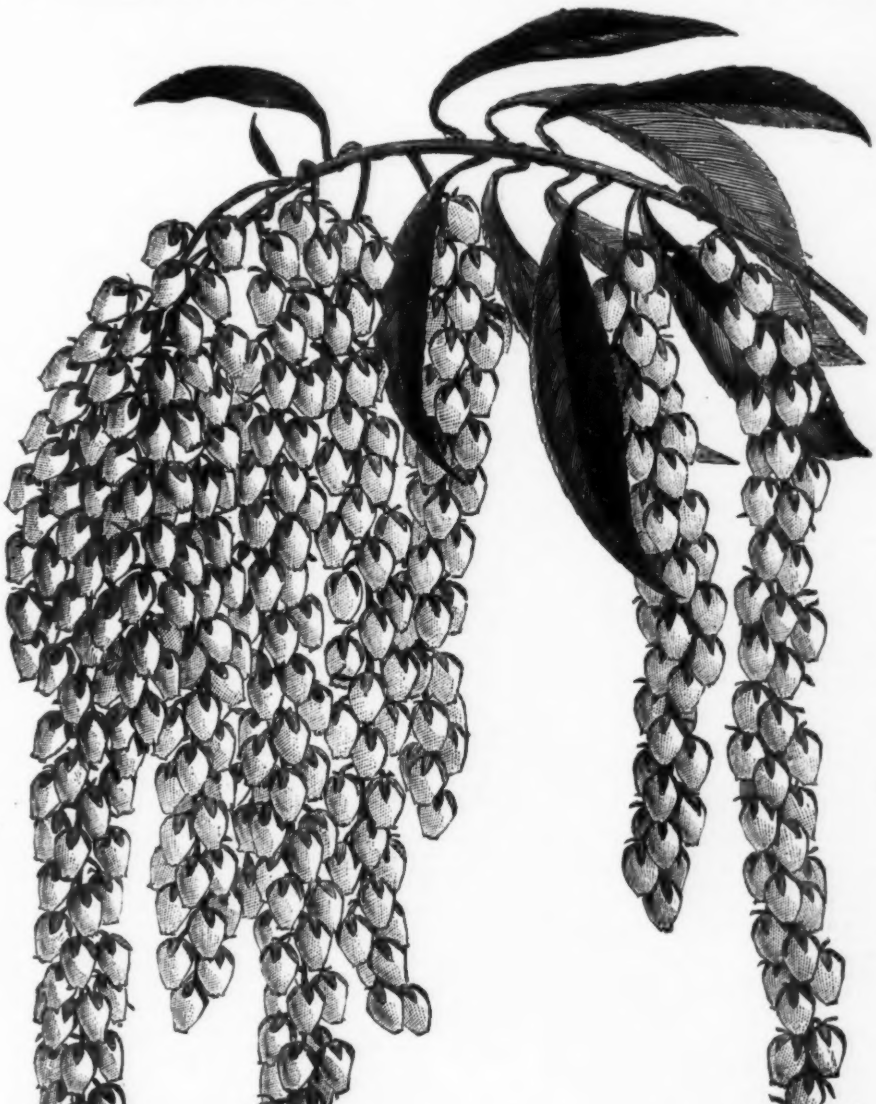
Charcoal made from the young trees of about one inch and a half in diameter, deprived of the bark, is highly esteemed in the manufacture of gunpowder. Seasoned wood affords a beautiful lampblack, but less abundant than that obtained from pine.

Farmers living near cedar swamps use the wood for fences. Cedar rails, with the bark removed, are very durable, and will last for fifty or sixty years. Formerly it was used in the frames of houses, but at the present time very little, if any, is used for that purpose.

This wood retains its good qualities if cut at any season.—*Bing.*

PIERIS JAPONICA.*

Our illustration was taken from a plant recently exhibited at the Royal Horticultural Society by Mr. Anthony Waterer.



PIERIS JAPONICA: HARDY SHRUB: FLOWERS WHITE.

It is a hardy shrub, with rather thick dark green lanceolate leaves, and long pendulous clusters of white urceolate flowers. Of its value as an ornamental shrub there can be no doubt, though it is rarely seen in gardens; this may arise partly from the fact that the illustrations hitherto published have been very miserable representations, taken from debilitated specimens, or from plants flowering a second time in autumn, so that the true character of the plant has not been shown. The plant is a native of Japan, in the gardens of which a variegated variety with yellow marginal variegation occurs, and also a dwarf variety. The plant is not new either to science or to gardens, since it was described as long ago as 1784 by Thunberg, in his "Flora Japonica," 181, t. 22, under the name of Andromeda japonica, and has been alluded to by many subsequent writers on Japanese plants, such as Miquel, Franchet, and Savatier. Maximowicz gives a careful description of it under the name of Andromeda japonica, in the "Melanges Biologiques" St. Petersburg, tom. 8, decas xii. (1872), p. 617. The name Pieris is here adopted because Don placed the plant in this genus, and his procedure has received the assent of Bentham and Hooker in their standard "Genera Plantarum"—*M. T. M., in Gardeners' Chronicle.*

* *Pieris japonica*, D. Don. ex *DC Prod.*, vii. 2, p. 590. *Andromeda japonica*, Thunb., *Fl. Japon.*, 181, t. 22 (1784); Miquel, *Prolusio*, 94; *Belgique Horticole* (1871), 272, t. xix.; Maximowicz, *Melanges Biologiques*, t. 8, decas xii. (1872), p. 617; Franchet and Savatier, *Enum. Pl. Japon.*

MR. JAY GOULD'S RESIDENCE ON THE HUDSON.

The people of Irvington had a most interesting and delightful way of spending the Fourth, offered to them by Mr. Jay Gould, whose beautiful grounds and conservatory at Lyndehurst were thrown open freely to all visitors under the supervision of his manager, Mr. Mangold, a scientific German horticulturist and practical botanist, who has conducted the improvements on the Lyndehurst property. Mr. Mangold is a native of Hanover, and an enthusiast in his art. He has been connected with this estate for eighteen years, and remembers when it was a wilderness, and a portion of it little better than a swamp. It is now one of the handsomest private estates in the country, and contains a conservatory which has no rival in the United States. It is located on the east bank of the Hudson River, about 25 miles from New York City.

"Vast sums have been expended to make this place what it is," said Mr. Mangold. "A mint of money was expended on the drainage alone. Over 95,000 feet of drain pipes, six by three inches, have been laid to carry the waste water into the river, and there have been over 5,000 feet of twelve-inch tiles driven at different portions of the place. The drainage is now perfect, so far as the main division of the land is concerned. This work was done when the estate was owned by Mr. Merritt, but Mr. Gould will begin the work of draining 280 acres lying about a mile to the north-east of the mansion in about six weeks. This will cost fully $100,000, but will be worth five times that amount to the neighborhood in the improved character and healthfulness of the land. Indeed, all of Mr. Gould's costly improvements and expensive luxuries are beneficial to the village. There is not a man, woman, or child, however poor and shabby, who has not the freedom of the grounds. Provided he behaves himself, he can obtain without price all the enjoyments for which Mr. Gould has expended thousands."

The estate comprises about five hundred acres, but is separated into two great sections by the public road. The main portion, containing the mansion, the conservatory, and the stables, which are particularly spacious and well built, comprises about ninety acres. The mansion, built of Sing Sing marble, crowns a knoll in the center of this part of the estate. The main part of the building was erected by Gen. Paulding, of revolutionary fame. An addition,

including a tower, was added by Mr. Merritt. The latter dying, Mr. Gould purchased the property of the executors. He has not added to the building, but of course has changed and improved the character of the interior.

Mr. Gould's hobby, however, is horticulture, and, with limitless means at his command, he has indulged himself in this matter with the same enthusiasm that other men bestow on fast horses or paintings, though he has a keen eye also for the good points of a horse, and is quietly making one of the best collections of pictures in the country.

While the reporter was going through the conservatories in company with Mr. Mangold, Mr. Gould came in, and seeing the admiration excited by his floral treasures took the pains to point out a number of the rarest and most beautiful plants with an animation that showed his warm personal interest in the subject and his familiarity with the *habitats* and properties of the palms, tree ferns, orchids, and other glories of the tropical forests which are here brought together.

The conservatories, which are new, those which Mr. Gould bought with the estate having been destroyed by a great fire in December, 1880, cover a vast area several hundred feet in length. They are constructed on a ground plan of the form of a Greek cross, the limbs centering upon a noble palm house, beneath the dome of which plays a large fountain, supplied, as are all the buildings of the estate, with water brought from an inexhaustible natural spring on the property.

While the old conservatories were still burning, Mr. Gould made his contracts for constructing these new and more magnificent buildings, which are absolutely fireproof, wood being used only in the framing of the glass between the great iron ribs. Mr. Mangold set about making lists of the plants required more than a year ago, and the collection of these plants has been ever since going on. It is not yet by any means completed, for Mr. Gould keeps himself fully informed in regard to the explorations which are making in all parts of the world, and it is his intention to get into these conservatories the finest procurable specimens of all procurable species and varieties of the tropical and sub-tropical flora.

"Mr. Gould," said Mr. Mangold, "by no means leaves everything to me. He takes a personal interest in every detail, and appears to be most happy when in the conservatory." In showing the reporter the beauties of the collection he grew enthusiastic over the varied shapes and colors of the "Crotons" imported from the Fiji Islands, through the kindness of Sir Arthur Gordon, the Governor of that colony, calling particular attention to one variety which develops a leaf curiously and accurately twisted into a spiral like a corkscrew of emerald and gold, and to another which produces a double leaf—that is to say, a leaf at the end of which is a stem holding another and smaller leaf. Recently Mr. Gould himself conducted several parties through the conservatory. A gentleman from Para, Brazil, and acquainted with the rich vegetation of that tropical region, was profuse in his exclamations of delight, and on leaving said: "I am to return in two years, when I shall take the liberty of visiting you again, and I fully expect to have my eyes opened still wider than I have to-day."

The new conservatory can be seen for miles up and down the river, there being a river view from the mansion of forty-five miles. The conservatory is 400 feet long on the northern line, and 32 feet wide. The central house, containing the collection of ferns and palms, is 87 feet deep and 80 feet long. The east wing, containing cacti, crotons, caladiums, and other tropical plants, is 80 feet long and 25 feet wide. The west wing is of the same size, and contains the rose houses and graperies. In addition to this building there is a rear house, 250 feet long and 18 feet deep, containing sections for propagation and the orchids or air plants. In all, there are sixteen sections. There are 75,000 feet of double thick glass in the building. Every precaution against fire has been taken. The building is arched with brick and iron beams, the chimneys are all on the outside, and hose is stretched throughout the building. A small brick building is in the course of erection to contain rooms for the accommodation of the watchmen, a potting department, and a seed room.

The building is heated by steam, there being six boilers in the basement for this purpose. In each section the pipes are so arranged that the temperature can be fixed independently of the adjoining sections. By this means fruits and grapes can be insured all the year round, as the vines can be kept in different stages of development, so that as the products of one section have been exhausted, those of the adjoining one will be ready for use. In most of the sections a trough of water runs the full length of the room, thus serving the double purpose of moistening the atmosphere and of supplying the attendants with water for the plants.

There are already in this monster conservatory over 4,000 varieties of plants. There is room for twice that number. The gardener estimates that there are from 6,000 to 8,000 plants in the conservatory and on the grounds. These are the products of every clime and every country. But it must not be supposed that these are all imported directly from their native country. Some of them are, but the vast majority come from the European conservatories, and especially from Belgium. There is no other private conservatory in this country of equal size and scope. Almost every wealthy gentleman maintains a hot house for flowers, but no other has undertaken to establish a full collection of plants. In Europe there are many private conservatories, but few which can compete with this. A walk through the building is enough to explain how it is that men spend lives in studying one plant or species of vegetable life. There is an infinite variety of forms and colors, and the senses are bewildered by the luxuriance of the scene. In one room there are 100 varieties of double geraniums in full bloom, making a bank of color simply gorgeous. One section, 80 feet long by 22 feet wide, is devoted to roses, of which there are 400 varieties. There are 400 varieties of palms, 300 of them from America and 100 from Asia. Some of the specimens cost from $250 to $500 each. There are forty varieties of the "pitcher" plant from Madagascar alone. There are 100 varieties of crotons from the Fiji and Solomon Islands; 500 varieties of plants from Central America, East Indies, and the Archipelago islands; sixty varieties of marantas from the Amazon River; a collection of ferns from Central and South America and the East Indies, 300 varieties, including some exceptionally fine tree ferns; 120 varieties of gloxinea. The collection of oracenas is the largest in the world. There are sixty kinds of bromelias and tillandsias. In a room artificially moistened are some 1,200 orchids, many of which are now in bloom, taking the eye at every turn with the weird animal forms and the inexpressibly delicate and beautiful hues of their blossoms. The collection of calladiums is very large. There are 200 varieties of camellias from Japan and China; 400 varieties of azaleas and many kinds of Indian rhododendrons. One or two sections are devoted to exotic grapes. In the fruit house luscious espalier peaches were almost dropping by reason of their weight. Among other interesting objects in the open grounds was a century plant, which has been shooting up its tall blossom at a rapid rate for a week past, and will break into flower when it has attained a growth of twelve or fifteen feet. The *Dionæa muscipula* of Carolina, which devours the flies which are so unfortunate as to enter its delicate throat, and the elk-horn fern from the East Indies, attracted the especial attention of the visitors. The flower garden comprises three acres, and the vegetable garden four acres. There is also a vineyard of two acres, and a large orchard containing some 400 apple trees and 500 pear trees. In Mr. Merritt's time about 1,500 ornamental trees, chiefly of foreign importation, were planted, which are now in full growth.

An importation of rare plants from Central Africa is expected to arrive soon for the conservatory.

In Mr. Gould's stables there are a number of fast horses, but he does not appear to desire to attain much distinction in that direction. The 280 acres alluded to above as soon to be drained will, the gardener says, be devoted to the raising of fine cattle.

It has already been said that everybody was admitted to the grounds; during the day as many as 120 carriages entered the gates.—*From the World.*

ARTIFICIAL PROPAGATION OF OYSTERS.

A REPORT of the studies of Mr. John A. Ryder on the artificial propagation of oysters, prepared for the *Times*, mentions as the chief bar to success the difficulty of keeping the young oysters alive more than six days. "From the fertilization of the egg until this time the growth of the young oyster can be readily followed. Professor Brooks was able to carry on oysters up to this critical period, the sixth day, and then they died. The shell seems to have made some slight progress as early as the twelfth hour, but the shell is extremely rudimentary, and it is not until the sixth day is past that the shell of the oyster larvæ becomes symmetrical, covering both sides with its valves. Now, the period of fixation of the oyster probably occurs immediately after this stage, when it is perhaps not more than ten days old, and the shell one-eightieth of an inch in diameter. If only the oyster, then, in its infancy could be carried beyond this stage in a proper incubating apparatus, it looks as if the aspiration of the ostraculturist would be realized, for he might then entertain the hope of easily restocking the exhausted oyster-beds of the United States. Mr. Ryder says: 'The artificial impregnation of the oyster may be accomplished to the extent of thousands of millions, and should it be found possible to keep these hosts of young alive until they have passed certain critical periods of their embryonic existence, we would have practically succeeded in adding so many millions of spat, from which seed might be supplied for the foundation of extensive beds where oysters had been previously unknown.'"

The real trouble with Mr. Ryder's work would seem to be its uselessness for practical purposes even if he should succeed in keeping all his spat alive. His aim is radically wrong, except so far as it may serve to secure for scientific ends the continuous life history under observation of one individual oyster. In view of the certainty and ease with which millions of millions of spat for seed are obtained by intelligent Connecticut oystermen by processes cheaply applicable to every foot of oyster ground on the Atlantic coast, Mr. Ryder's plan of raising oysters by hand is amusing rather than valuable. If it succeeded it would not pay, and it could not succeed even on the smallest scale, unless provision were made for the care of the young oyster for a year or more, for which purpose a nursery a square mile in extent would be inadequate.

The *Times* report goes on to say that in the course of Mr. Ryder's studies during the past two years "three different forms of apparatus have been experimented with, but with poor success. It was found impossible to confine the minute eggs of the oyster without the use of some kind of bibulous or porous paper. This paper became clogged with the sediment and slime found in sea water, so that practically no form of apparatus in which porous membranes were used gave satisfactory results. It is now proposed to abandon the use of apparatus constructed on this principle and conduct the incubation in shallow dishes containing the eggs in salt water, over which jets of air will be blown. The credit of this method is due to Prof. S. I. Smith, of Yale, who has used this plan with considerable success during the last season at Wood's Holl. If Mr. John A. Ryder can succeed, then, in his experiments of rearing the oyster, so that it shall pass the dangerous stage before described, his work will be of inestimable value, and the difficult problem of ostraculture will be solved. After that the growth of the oyster will present no great difficulty, for when once fixed its development can be easily followed."

The bearing of all this on the practical problem of "ostraculture" is not clear. A tea plant can be raised in a flower-pot, but when done the work will not have materially advanced the problem of displacing foreign teas in our markets by teas of home production. The marketable Norwalk oyster from spat artificially secured is from three to six years growing; it has to be transplanted and otherwise handled several times; it has to be protected from numerous enemies, human and marine, while growing, and finally it sells for two cents. At that price it would not pay to rear it by hand in a saucer, even if it were possible to do so.

If thrifty oyster spawn were scarce and hard to get, it might be advisable to attempt their cultivation in pans, provided the young brood could be transplanted to open water when fairly started; but the water of our Atlantic coast swarms with spat at intervals during the early summer, as may be proved by offering a clean surface of wood, stone, shell, or other substance anywhere at the proper time for them to fasten upon; so that this product of spat is not an element of the practical problem. The real difficulty lies in presenting to them at the critical moment clean stools to fix upon.

The next practical fault with Mr. Ryder's plan arises from the impracticability of transplanting his "seed" after it is grown, or rather of keeping his spat until it is big enough to be safely transplanted. When old shells or other "stools" are thickly set with seed, six or eight months old (or younger if the seed is very abundant), the stools may be strewn broadcast in deep or shallow water, on mud or gravel bottom, where the oysters are wanted, with a fair chance that enough of the seed will be favorably placed for survival and growth to secure an abundant crop, unless destroyed by starfish, drills, or other vermin. Detached seed, such as Mr. Ryder seeks to get, would simply be smothered in the mud and slime of the bottom and come to nothing. After the first few days of its life, the young oyster is incapable of attaching its shell to a suitable stool, and for the first year or so, under the average condition of oyster beds, it is equally incapable of maintaining itself unless so attached. In view of these facts, the attempt to imitate in oyster culture the methods employed for free swimming fishes is simply absurd. The problems involved are in every respect unlike.

THE WILD BOAR AND ITS YOUNG.

IN many of the forests of Germany the wild boar is frequently found, and hunting parties for the pursuit of this formidable animal are very often arranged among the nobility of Germany, especially on St. Hubert's Day. On this day the aged emperor never fails to attend. A boar hunt is connected with considerable danger, for, if the animal is wounded, it becomes so enraged that even the most skilled marksman is often unable to wound it fatally, and it must be slain by presenting a knife or short sword to the animal's breast, in such a manner that it will run upon the same. This manner of slaying these animals requires extraordinary skill, nerve, and courage. In hunting the wild boar hounds are used which are all more or less related to the shepherd's dog. They are not distinguished from other dogs by form or color, but by their peculiar training, as they can be used for hunting boars and for that purpose only. A few are generally sent ahead as pilots, to look for the boar; they remain perfectly quiet while searching the woods, but as soon as they have found the animal they give a signal by barking very loudly. The rest of the hounds are then released, and they throw themselves on the boar from all sides. A few are generally severely wounded or killed in the struggle by the enormous tusks of the boar. The opposite cut, which is a copy of the painting by the celebrated artist, Ludwig Beckmann, represents a wild boar with its young; the old boar is rooting, and the young immediately root among the loosened earth to hunt for worms or bugs. The old boar generally chews roots, herbs, etc., for the young, which devour them. They are always hungry and are always fighting for the best part; if one of them succeeds in finding a snake, a large worm, or any other morsel of which they are especially fond, the rest are sure to follow, and the meal usually ends in a general fight, which does not terminate until the old boar separates them and expresses her dissatisfaction by emphatic grunts.—*Leipziger Illustrirte Zeitung.*

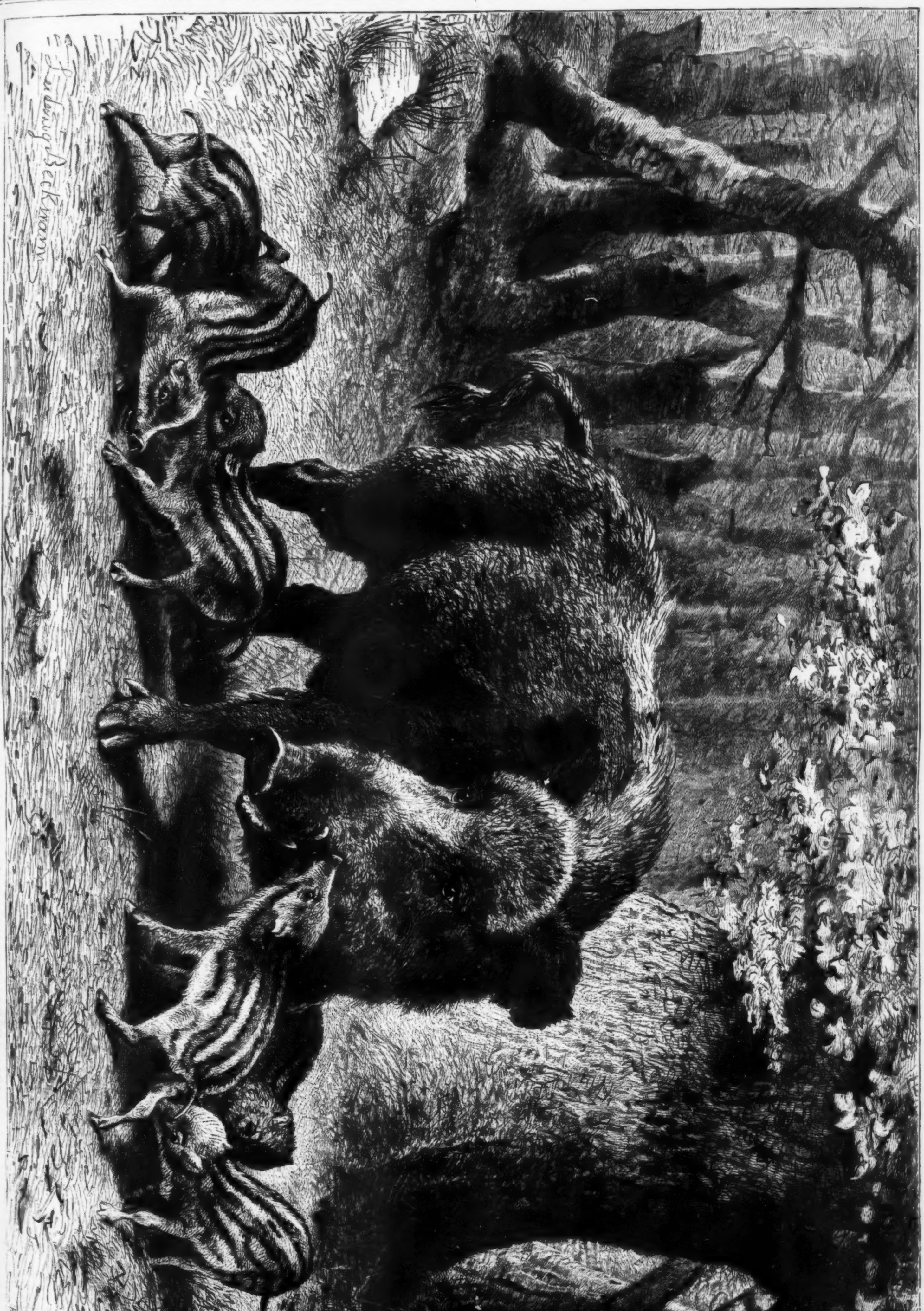
CAREER OF A MAN-EATING TIGRESS.

FOR more than a year past a man-eating tigress has been the terror and scourge of a small tract of hill country in Western Garhwal, which looks down across the Ganges upon the sacred shrine of Rikhikesh. From first to last she is said to have killed between 50 and 60 human beings. A considerably higher estimate, indeed, is current in the neighborhood. Last year she became a proclaimed offender, and a reward of 400 rupees was set upon her head. So widely infamous did she become that it is somewhat surprising she did not obtain more attention from the sporting manhood of our cantonments, particularly when it is considered that her haunts were within two marches of so well-known and accessible a place as Hurdwar. Such attempts, however, as were made to circumvent her, whether on the part of forest hunters and others, or natives, invariably failed. Her wariness and activity seemed to be altogether extraordinary. From some spot on the hillside she would watch a group at work in the fields, and regularly stalk them by careful and circuitous approaches; then, dashing in among them, she would pick off her victim, and in a few seconds be down the side of one hill and under covert up another almost before his companions had time to look around. The sound of bamboo-cutting was so well-known to attract her that that industry for the time entirely ceased within her beat. Of course occasional failures are recorded against her; one plucky fellow cudgeled her off the friend she seized by his side with a *lathi;* and in another instance she abandoned her prey owing to the lucky circumstance of a mouthful of the bamboo bundle on his back failing to please her taste. But these were rare exceptions to the monotonous tale of slaughter. One of the very last cases was a particularly painful one. A peasant's wife objected to go to work in the fields, or rather cultivated terraces, pleading her fear of this beast; the husband forced or persuaded her to go, promising to accompany her and stay near her while she worked. She was carried off before his eyes. People on the look-out for this tigress with fire arms could never find her; cattle she never killed; to elephants her haunts were inaccessible, and it seemed clear that if she were ever destroyed it would be off the corpse of a human being or the carcass of a langur, the only animal besides man on which she was known to prey. And so it turned out. About a fortnight ago the Senior Assistant Commissioner of Garhwal obtained the services of a dozen Goorkhas from the regiment quartered at Dehra; these plucky little men had only been a day or two across the river, when, on the 9th inst., the tigress killed again another woman. They started for the spot in the afternoon, four of them going along the hillside in advance, while the rest of the party kept along the nullah; the tigress, startled by the latter, broke in front of the former, and, luckily having her back broken by the first shot of the volley fired at her, succumbed without a struggle. Not only was the tigress apparently killed off the body, but some of the victim's fingers were found in her stomach.—*Allahabad (India) Pioneer.*

A LIGNIFIED SNAKE FROM BRAZIL.

SCIENCE explains at the present day facts which, several centuries ago, would have been regarded as marvelous, magical, and, doubtless, works of the devil. It is probable that if the curious illustration (Fig. 1) which accompanies these lines had been published in the middle ages, the imagination of the public would have been startled at the serpent that is here seen incorporated with a piece of wood. Who would not have recognized under such a symbolic form the great Tempter, Satan himself, embracing in his perfidious folds the tree of good and evil? It is true that what would have been a subject of terror for the vulgar, would have been the most natural thing in the world for grave people. Familiar with bird-bearing trees, the learned of the period would have seen a tree give birth to a reptile, without the least surprise. Do not Saxo Grammaticus, Sebastian Munster, Thomas de Cantimpré, Olaus Magnus, and many others speak to us in their learned works of ducks and barnacles that issued forth from the fruits of several trees in Scotland and the islands of the north? Before assuming their plumage the future birds must have exhibited a vegetable appearance: and it is such a transitory phase as that that the annexed figure

WILD BOAR AND HER YOUNG.—DRAWN FROM NATURE BY LUDWIG BECKMANN.



WILD BOAR AND HER YOUNG.—DRAWN FROM NATURE BY LUDWIG BECKMANN.

(Fig. 1) gives us a good idea of. The figure is a reduction of one-half from nature, and the piece of wood that it represents exhibits, in a ligneous state, on one of its surfaces, a singular figure, whose relief, general form, and external structure is that of a snake. I owe the communication of this to Mr. Lopes-Netto, envoy extraordinary and minister plenipotentiary of the Emperor of Brazil to the United States of America. As well known, this sovereign, who is a corresponding member of the Institute of France, accords a warm protection to the sciences, and endeavors to disseminate the benefits derived therefrom throughout his vast empire. Having united at Rio de Janeiro a society of European savants, he has constituted around him a sort of an academy in which are discussed all scientific questions. It was in this cultivated circle that the piece of wood under consideration was the object of careful examination. In view of the contradictory opinions that were advanced on the subject of the unusual phenomenon observed here, Mr. Netto thought it would prove of interest to science to make it known in Europe; and, as soon as he arrived in France, he hastened to ask an explanation of it. He has kindly permitted me to make a detailed study of the object, and then to submit the result thereof to the Botanical Society. Such consequently found at the periphery of the wood; toward the exterior, on the contrary, it produces, in a centrifugal direction, liber fibers, elongated cells, and prosenchymatous elements, the youngest of which are, therefore, situated on the internal surface of the bark. If, then, a foreign body be introduced as far as the external limit of the wood, it will, in a few years, become invested with a series of ligneous layers, themselves protected by an abundance of bark. Now, in the case under consideration, not only has there been an investment of concentric zones around the reptile, but, besides this, cells and ligneous fibers derived from the cambial tissues have been substituted for the elements which constituted the peripheral portions of the snake, in measure as the latter have become absorbed. The places that these occupied have, in all the phases of their disappearance, been taken by secondary wood, whose hypertrophy is proved by the very relief of the snake's body.

About ten years ago there was cut down near Elbeuf a forest, one of the trees of which had been a long time previously marked with the letter "B" to indicate a boundary. The mark had been made, according to custom, with a red-hot iron, and it had penetrated the tree to some depth. When this was cut into pieces it was still very prominent on the surface of the bark (Fig. 2). A stroke of the ax, given by the wood-cutter parallel with the axis of the trunk in the external region of the wood, vulgarly called the sap-wood, discovered two absolutely plane surfaces, neither of which bore scarcely a trace of the letter; but a little further from the edge of the ligneous disk a second cut brought to light the mark "B" identical with the one presented by the surface of the bark itself. This remarkable example of the double function of the cambial layer, that may be seen in the museum of Mr. Noury, is not the only one known in this class of cellular formations. The Botanical Gallery of the Museum of Natural History, at Paris, possesses a trunk of a tree a part of which has enveloped the base of a deer's antler. But truly speaking this specimen offers only a phenomenon of growth around a foreign body, while the lignified snake from Brazil gives proof of the substitution of vegetable cells for the different elements of which the living reptile was composed. There is here a very important fact for the history of organized tissues; and thanks are due to Mr. Netto, who was the first to perceive the value of it, for having permitted us to establish it.—*Louis Olivier, in La Nature.*

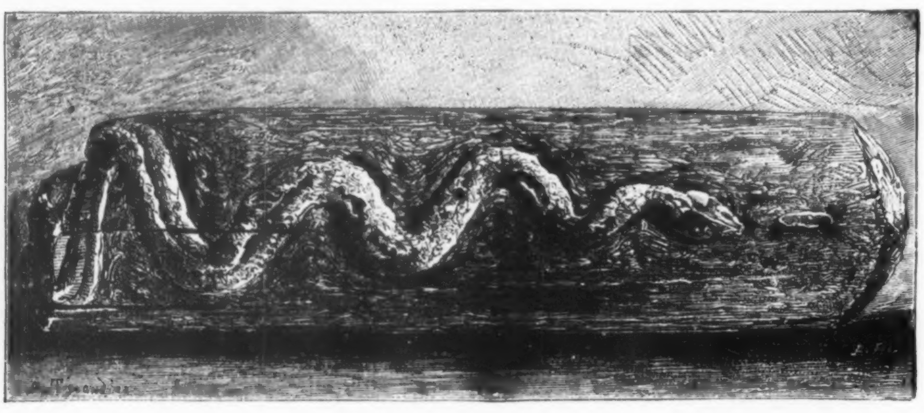


FIG. 1.—LIGNIFIED REPTILE FROM MATTO GROSSO. (½ Natural Size.)

control by a very competent assemblage appeared to me especially necessary in a matter like this where deceit is often to be feared. Observation with a lens had convinced me that the relief of the snake could not be attributed to the intervention of human hands, and my colleagues, like myself, have been able to establish an irrefutable character of authenticity for it, without which the object would have lost all value. Yet it was impossible to see anything but a mere accident in this strange reptilian figure, in which the head, neck, and other parts of the body were so clearly defined. In several regions of the body, very delicate details of the animal's organization are clearly visible. It is so with regard to the nostrils and ocular orbits; and over an entire half of the surface of the head may be distinguished the arrangement of the scales and cephalic plates. It is then, indeed, a true snake that we have before our eyes; and to those who are acquainted with the little Brazilian *Jara caca* the identity of the two seems evident.

This latter animal, which is one of the most venomous and most to be dreaded in the country, is very common in the province of Matto Grosso, to the north of the Amazon, and it is precisely from that region that the trunk of *Ipé-Mirim* came, in the interior of which the image of the snake was found. It must be admitted, then, that the reptile has introduced itself therein. But what is astonishing is that the entire body of the snake is lignified.* The anatomical study that I have made of it has shown me that it consists of cells and fibers like those of the secondary wood which surrounds it. It is impossible to explain the fact by saying that there has occurred a formation of these elements in a channel, which, having been traversed by the animal, has preserved the form of the latter; for on the piece of wood it is not only the contour of the snake that is visible, but indeed the whole relief of its body.

In the prolongation of the head there is likewise observed in relief a little cylinder which appears to be referable to the larva of an insect. It seems, then, that the snake, in pursuing the latter into the fissure in a tree, has insinuated itself into that very place where the proverb forbids the finger to be put, between the wood and the bark, that is to say, into that cambial zone that is well known to be the generator of wood and secondary liber. The function of this cambial tissue is twofold: in the interior it gives rise, in a centripetal direction, to ligneous elements, the youngest of which are

* Except the center, in which are found the constituent elements of the animal.

A NEW HYGROMETER.

IN a recent note to the Paris Academy, M. Crova has described an instrument for measuring the moisture of the air not subject to the uncertainty characterizing the indications of previous instruments when the air is agitated. The observer looks through a tube toward a source of light. This tube is of nickel-plated brass, highly polished within, closed at the further end with ground glass and at the nearer with a lens. The ground glass plate appears as a luminous disk, and the polished interior, by its reflected light, has the aspect of a bright annular space around the disk. The air whose moisture is to be ascertained passes slowly along the tube, entering and leaving by tubulures at the ends connected with a suction arrangement. To cool the tube, it is surrounded by a metallic sleeve filled with sulphide of carbon, through which an air current is passed. A thermometer is inserted in this liquid. When the temperature of the air under examination reaches saturation, dew is deposited, appearing like dark brown spots, which contrast strongly with the bright disk when seen directly. A gradual rise of temperature makes these disappear, and thus, by repeated appearances and disappearances, the dewpoint may be estimated with an approximation of one tenth of a degree.

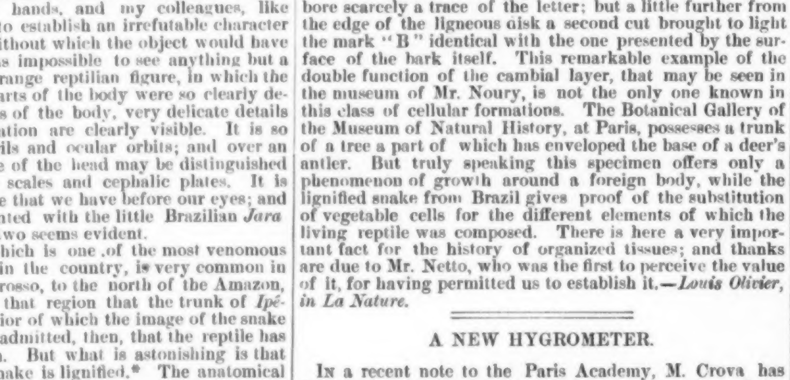


FIG. 2.—A, Log of wood which had been branded with the letter "B." B, Fragments separated from the log, showing the letter impressed on the pieces 1 and 3, and not on the piece 2.

THE MICROSCOPE, AND SOME OF ITS RECENT REVELATIONS.*

By JOHN ROGERS, F.R.M.S.

A QUESTION which every microscopist has to answer many times is, What does a microscope cost? The best answer is, perhaps, that an ordinary instrument costs from 10s. to £10, and a superior instrument from £10 to £400. There are two items of considerable expense—the stand and the object-glasses. The stand may include mechanical work of a costly kind. The best stand, alone, by Ross, Powell & Lealand, or Beck, will range from £35 to £45, while the American Folles-Blackman stand is £63. A set of 14 object-glasses, from 4 inches to 1-50 inch, by the same makers, may come to nearly £130, and a set of 14, by Folles, 4 inches to 1-25 inch, will be about £215, while the highest power made by Spencer or Gundlach are 50 guineas each. There are microscopists distinguished for their attainments and discoveries whose instrument and apparatus would not exceed £10 in value, while others use an outfit that could not be purchased for less than £500. More depends upon the knowledge and skill of the person who uses the instrument than upon its cost, and the fact remains that the greatest discoveries have been made with instruments of comparatively small price. The great Leeuwenhoek made every part of the instruments he used with his own hands, and they contained only a single lens each. The illustrious Lieberkuhn, also, made his own instruments. The microscopes of both these celebrated men can be seen in the collection of the Royal Society and the Museum of the Royal College of Surgeons, and, except as a curiosity, they are all of small money value. The great discoveries of Ehrenberg, in the present generation, were all made with a modern microscope that would not cost £5. On the other hand, a century ago, a microscope of wonderfully fine workmanship, worth £100, was made for King George III., yet neither the King, nor any one else, has done work of any value with that instrument. Early in the present century two object-glasses were made with lenses of diamond, of immense cost, yet with these no discoveries were made that have lived to the present day.

Another question constantly asked is, What is the power of this instrument? How many times does it magnify? And the questioner's admiration is usually in proportion to the number of figures contained in the answer. This folly has been played upon to a large extent by the charlatans who make cheap magnifying glasses, and advertise them as "Microscopes that will reveal monsters in a drop of water; show the human skin to be covered with hairs, like a forest of pine-trees; and under which parasites are seen walking about on a leaf like cows in a pasture." A most absurd statement on the face of it! No microscopist answers the question in this form. A cubical magnification of 1,000,000 times is an enlargement of 10,000 in superficial area, and is precisely the same thing as 100 diameters. Magnifying-power is always spoken of, by those who know anything about it, by the number of diameters. As a general rule, it may be understood that object-glasses which give, with the A, or 2-inch ocular, the following amplifications (represented by the actual focus of a single lens) are classified under their nominal focus, as:

Low powers, 10 to 75 diameters,	5 in. to	$\frac{2}{3}$	in. objective.
Medium powers, 100 to 250	" $\frac{1}{2}$	$\frac{1}{5}$	"
High powers, 300 to 1,000	" $\frac{1}{4}$	$\frac{1}{20}$	"
Very high powers, 1,250 to 4,000	" $\frac{1}{25}$	$\frac{1}{50}$	"

It is a common error to make the value of a microscope depend exclusively upon how much it will magnify. The most worthless instrument may magnify highly, but magnifying-power alone is of small value, for more can be seen with a good instrument and a power of 100 diameters than with a poor one of 500; the important point is what will a microscope show. This will depend partly upon the objective, but also quite as much upon the observer. An uneducated and untrained eye will see little of what is before it, and will only partially understand that little. For instance, the entire field visible with 1,000 diameters is 1-150 inch across, and occupies a space ordinarily invisible to the naked eye; it requires skillful manipulation to place an object within so small a field at all. With 750 diameters it is impossible to see the whole of the foot of a fly, you might see a single claw or a single pad, but without some knowledge of the structure of a fly's foot, as a whole, no clear ideas could be obtained with such high powers. This is one reason why high powers cannot be shown with any advantage to general observers.

Another reason why low powers only are of use to untrained eyes is, that the depth perspective decreases very rapidly, and beyond 1,000 diameters the microscopic image of solid objects passes more and more into pure transverse sections, and any appreciable depth of focus ceases; at the same time the magnification of the depth seen increases in inverse proportion to the diminished diameter. As you approach 1,000 diameters difficulties commence with regard to the light, and lamps, prisms, or condensers of the best construction become necessary, and require to be used with great skill. At this point, also, specially-prepared objects, to lie accurately in the same plane, are absolutely needed, and glass covers, 1-200 inch thick, become difficult to work; glass of extreme tenuity, of 8-100 inch, and the thinnest films of talc become useful with water immersion, then glycerine, oil, and lastly homogeneous fluids of the same refractive angle as the densest glass, with immersion condensers to correspond. Working on this line 10,000 or 15,000 diameters may be reached, with a loss at every step. It is claimed that modern amplifiers will bring this up to 32,500, but it is not easy to see, and sunlight is necessary to see anything; while even 100,000 has been spoken of as possible, but it is doubted if, even with the electric light, anything whatever can be revealed with such excessive amplification.

In the opinion of the most accomplished manipulators there is a line beyond which nothing is gained by higher amplification. Amici and Sir John Herschel considered this limit to be 3,000 diameters. Hartnack has never shown anything better than at 3,000 diameters. Nobert's 19th band was first resolved with 550 diameters, and Dr. Woodward, of Washington, photographed it with 2,000 diameters; while, with every resource of modern apparatus, he is content with 3,000 as the limit of the best results with the best objectives in the world. The Rev W. H. Dallinger states his best results as under 4,000 diameters, and the opinion of the greatest living microscopists familiar with the highest powers is that beyond 5,000 or 6,000 diameters there is no further visible resolving-power, but that 3,000 or 4,000 will amply represent the practical limit. The highest-power

* A paper read before the Nottingham and Notts Chemists' Association, February 23, 1882.

objective ever made, the 1-80 inch, was exhibited some ten years ago by the most celebrated maker of very high powers, and, although those present were all microscopists, not more than four out of five could see anything with it. The amplification was about 6,000 diameters, and a single mark upon a scale of the podura filled the entire field; it was a familiar object to all, but the observers were by no means unanimous as to what they saw.

A very popular question is, Will the microscope show the animalcules in water? Many of the animalcules in stagnant water can be seen by the naked eye, without the aid of any instrument, and others can only be seen with exceptional instruments. Pure spring and rain water, so far from being devoid of animal and vegetable life, in its best condition often contains rotifers, infusoria, entomostraca, diatoms, desmids, and algæ, which to the microscopist attest by their characters the purity of its source and general good quality. These are invisible to the naked eye; some may be seen with a low power, but most will require a high power to render them visible. So that seeing animalcules in water is no definite test for a microscope. Powers of 15 to 20 diameters will show objects that are otherwise perfectly invisible; while 50 diameters will bring to view the most beautiful objects described in ordinary books. Leeuwenhoek made all his discoveries with powers from 40 to 160 diameters. All that can be seen by the higher powers is intelligible only to the specialist or the student of some branch of science, and the objects themselves, having no common names, are known only to scientific men.

The wise question may be asked: What will the microscope show that would otherwise be unknown? The answer to this question is already very large, and it grows every day. It is only possible now to state some of the latest additions to our knowledge from this source.

For the detection of forgery there is no expert equal to the microscope. The examination of handwriting with a view to determine its authorship, its genuineness, its age, and whether or not it has been altered from its original form and intent, is one of the most recent uses of this instrument, and one the importance of which has but recently become known, and is even now not generally realized. In a recent case a microscopist established the date of a document by recognizing in the paper fibers only recently used in paper-making, which demonstrated that the paper was manufactured at a later date than that claimed by the writing upon it. Writing can scarcely be changed, after its original execution, so adroitly but that the microscope can detect the falsification. The face of the paper, when once marred by disturbing the position of the fibers, can never be restored, and hence scratching and erasure can be recognized, though performed with consummate skill. Inks, alike to the unaided eye, are marked under the lenses by conspicuous differences of shade, color, or density. Lines which look simple and honest may show themselves as retouched, or altered, by the same or by a different hand, or pen, or ink; and lines drawn upon new paper look different from those drawn after it is old. The microscope will give valuable information as to the relative age of superimposed, crossing, or touching lines, and state positively whether lines were written before or after related erasures, or scratchings, or foldings, or crumpings of the paper. If the signature has been constructed by tracing it with pencil lines over an original, and subsequently inking it with a pen, particles of plumbago can be somewhere detected. If copied or imitated originally in ink, the distribution of ink is peculiar and suggestive, indicating hesitation from uncertainty, or pauses to look at a copy, or to recall a style, or to decide on a future course, just at points where a person writing his own name would pass over the paper most rapidly and promptly.

There is no form of forgery so difficult to detect as that of the most cunning free-hand imitations done with practiced skill; yet for this there is a test, which is entirely and alone within the province of the microscope. A genuine signature is automatic; no close attention of the will is required, and there is a minute rhythm caused by the action of the small muscles, in regulating the amount of pressure upon the pen; it is quite imperceptible to the naked eye, and cannot be accurately determined by a simple magnifier. These variations of pressure differ with individuals from 200 to 300 to the inch, and are as regular as they are spontaneous and involuntary. When a man writes naturally the pressure variations are rhythmical, while, on the contrary, when he is consciously imitating the writing of another, they are irregular and unsymmetrical. As a matter of microscopic analysis the hand always trembles, and must do while the heart beats and the nerve impulses follow each other in rapid succession. In health this rhythm of progress is perfect and regular, but its regularity is broken by mental excitement and destroyed by voluntary effort. Now, forgery is impossible without one or both of these interfering agents.

There is another subject, far removed from this, upon which new light has been recently brought by the microscope. That there are other worlds than this we know from the revelations of the telescope, and that some of these have an atmosphere and clouds; but those we can observe best are so far from the sun that we know nothing of the possible conditions of life in those distant orbs, so full of interest to the astronomer and the poet. There are, however, at frequent intervals meteors which visit us from outer space, and becoming incandescent in their rapid flight through our atmosphere, are visible; not infrequently they are caught by the attraction of the earth and fall. The chemical analysis of these stones shows that of the 70 or more elements known to exist, 23 have been found and recognized, and no element has yet been found in meteorites with which we are not familiar. Quartz and feldspar, so common here, are absent, while the metals, with the minerals enstatite and olivine, constantly occur. A microscopic examination of the sections of meteorites reveals evidence of organic life, both animal and vegetable. At present, corals and sponges, with about 50 species of polypes, crinoids, and algæ, have been found; in all, 130 different forms and structures have been photographed by Dr. Hahn. These celestial fossils tell us of a planet on which aquatic life was sufficiently developed to produce them, and to preserve them after death, by a process of infiltration of silicious material, which dissolved the lime of which their structure must have consisted, so far as their inorganic constituents are concerned, and supplanted it by various kinds of silicious materials, filling up also the interstices and openings which had formerly contained organic substance. This planet, therefore, must have had a comparatively long period of existence; it must have had an atmosphere, and its surface must, in whole or in part, have been covered by water. The corals would seem to show that this was a warm sea of a sunny climate, for we find corals on the earth at the temperature of 80° F. The most marked feature about these fossils is their diminutive size; the spicula of sponges being so small that they are indistinguishable by the naked eye. We have here a revelation of life beyond the confines of our world, brought to our knowledge from outer space by the microscope.

To descend from cosmos to the counter. One of the plagues of our modern civilization is, that adulteration has been reduced to an art—neither food nor medicine is safe from its insidious cunning; and here the microscope provides a salutary check. In dealing with roots, the transverse and longitudinal sections, especially when their structure is differentiated by double staining, will give in minute detail certain evidence of identity. With leaves, the hairs upon the cuticle and the stomata afford ample means to distinguish with positive accuracy. While with decoctions and tinctures the microspectroscope, carefully studied, will discover the minutest differences of composition. With all salts the polariscope and the goniometer will classify perfectly those that otherwise may be most difficult to distinguish. And even with substances reduced to powder, the microscopic examination will generally be sufficient to detect the introduction of a foreign or alien substance.

In the article of food, adulteration has long had a very extensive and lucrative field. For the last twenty years a patent has been diligently worked in London by which animal fat has been cleaned and purified to a tasteless, odorless, colorless substance, which is then colored and flavored to represent butter. Being exposed to a fair degree of heat in the process, the result was not objectionable as a matter of health so much as of fact and sentiment. Our cousins across the Atlantic have not been so fortunate; the oleomargarine which is largely manufactured for their use, and possibly for ours—for, in fact, a few cases have already appeared in the imports—is known to be made from refuse animal fats, in no part of the process subjected to a higher heat than 120° F. This, coupled with the result of a recent microscopical examination, suggests a grave danger.

In outward appearance, oleomargarine would be accepted by the ordinary purchaser as genuine butter. Under the microscope crystals of sodium chloride were present, not so clean and characteristic as those found in dairy butter—but here all resemblance ended; crystals of sodium nitrate were prominent with another form, closely resembling cholesterine, found in considerable numbers, besides these crystals, fatty globules, totally different from pure dairy butter, and suspicious cells were abundant, accompanied by shreds and tissue fiber in patches, many in a broken-down condition, with elementary fibers detached, and a form strongly suggestive of encysted hydatids, thus forming a medium for the introduction of entozoa and ectozoa of the most dangerous class. A thorough microscopic investigation of oleomargarine is impending in the United States, where manufactories of this article are in operation on the most extensive scale. An adulteration of the same class is imported into this country from Germany and France, under the name of butterine. In appearance and taste it will pass for butter, but, as it is certainly made from animal fat, its difference from oleomargarine is merely a matter of quality, or possibly of name only, and the substance well deserves attention at the hands of the analyst and microscopist.

For analysis the microscope is invaluable; it makes possible a series of examinations with the most minute quantity of material. Take, for instance, a suspected blood stain, from which the 1-25,000 part of a grain can be scraped with a knife; place this on a glass slip, with a microscopic dot of glycerine, to give a solution of hæmoglobin, with 100 diameters and the microspectroscope the spectra of blood may be observed and modified, for confirmation, by a mere dot of solution of sulphuret of sodium; by moving the stage the colored fluid will be partly drained away, and, if the specimen be blood, with 1,200 diameters and an eye-piece micrometer the corpuscles may be measured accurately enough to discriminate between human blood and that of an ox, pig, horse, or sheep; and lastly, the minute blood-stain may be wiped off the glass slide on to a slip of moistened white blotting-paper; drop upon it fresh tincture of guaiacum, and then a drop of ozonized ether, which will at once strike the dark-blue color of the guaiacum test for blood. In this way may be obtained three kinds of evidence:

Spectrum analysis;

Microscopic measurement; and

Chemical reaction from a single particle which weighed less than 1-25,000 part of a grain.

The micro-analysis of poisons has been ably treated, with regard to chemical reaction, in several important works; but when the quantity is very minute or much diffused the microscope furnishes a remarkably delicate test of the presence of poisons when they are in too minute quantities to answer any chemical test, especially those poisonous alkaloids for which no chemical test is known. Take a drop of water containing infusoria, place it upon a glass slide, and examine carefully, noting their size, form, and color. Then place a drop of the suspected solution at the edge of the fluid containing the infusoria. If organic poisons be present, the infusoria are instantly destroyed, and become a formless sediment. Professor Rossbach, of Vienna, states that: "If a drop of water containing infusoria and weighing the 0·001 of a grain be used, the quantity of strychnine required to cause remarkable changes will be 0·00000006 of a grain. In this way the 1-15,000,000 part of a grain of atropine can be detected." Thus, if the stomach of a person poisoned by strychnia contain a liter of fluid and only three quarters of a grain of the alkaloid, a single drop of this fluid will contain forty times as much strychnine as is necessary for the test.

In this paper an endeavor has been made to answer some of those questions which occur whenever a microscope is shown, and to bring forward a few of the latest additions to our knowledge from its use. The microscope is now recognized to be indispensable to the physician and the surgeon. The age of ignorance, in which it was regarded as an instrument belonging to magic rather than to science, is past, and the period of half-knowledge which persisted in regarding it as a curiosity or a toy is passing away, and there can be little doubt that in the future some familiarity with its use will be absolutely necessary for the chemist, for whom it will verify facts and act as a protection from those frauds and adulterations which are never more mischievous and dangerous than when introduced into the chemicals and drugs for whose genuineness and purity the chemists and druggists of to-day have such an honorable reputation, that the lives of others are constantly confided to their knowledge and skill with absolute confidence and perfect safety.

To reduce zinc to powder, the best plan is to pour the melting zinc into a dry and warm cast iron mortar, and as soon as it shows signs of solidifying pound it with the pestle.

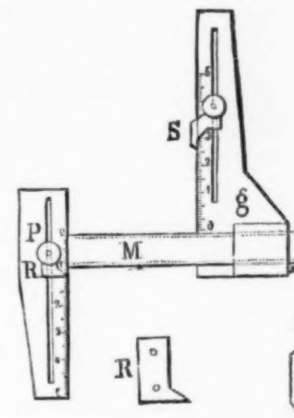
INSTRUMENT FOR TRACING CURVES BY POINTS.

When it becomes necessary to trace on the map of a survey a curve of a level of given altitude, it is necessary, in order to find the points of such a curve, to perform quite a simple operation, which consists in the construction of two similar triangles. As the tracing of the curve is so much the more exact in proportion as the points are more numerous, it is readily seen that in order to attain very great precision a large number of triangles will have to be constructed, and the plan overcharged with lines, all of which will take considerable time.

To remedy such an inconvenience Mr. Perron has conceived the idea of constructing a small instrument which permits of performing mechanically the operation that we have just spoken of.

The apparatus consists of a flat ruler, M, on which slides, with slight friction, a piece, *g*, which has the form of an elongated triangle. The edge of this movable piece is perpendicular to the upper edge of the rule, M. Another piece, P, of the same form as the preceding, is fixed firmly to the rule, M. and has its edge also perpendicular to that of the latter, but turned in an opposite direction to that of *g*. These are the two pieces whose edges are to constitute the homologous sides of the like triangles. In each of them there is a longitudinal slot, parallel with the edges, and which permits of the index-slides, R and S, moving in such a way that their points slide along the edges of *g* and P. These slides are fixed in position by means of screws.

The edges of each of the pieces, *g* and P, are divided off into centimeters, millimeters, and demi-millimeters, and the divisions are placed in such a way that their zeros coincide exactly with the upper edge of the rule, M. As shown in the figure, the slides terminate laterally in sloping sides, and their inner edges slide along the divisions. These forms permit any flat ruler whatever to be applied against their points, and that, too, in whatever position the slides may be.



With this explanation the mechanism of the instrument will be readily understood. The zeros of the pieces, P and *g*, are placed on the two points whose heights are known, and the slides are so placed that their points, starting from the respective zeros, determine divisions that are of lengths equal or proportional to the differences between the heights known and that of the point sought. A ruler is then applied against the points of the slides, and the point at which this meets the upper edge of the rule, M, gives the point sought. There are obtained by this means the points of a same curve of level with as great an accuracy as by the ordinary graphic method; the paper does not have to be filled with a quantity of useless lines that have to be afterward erased; and, in addition to this, the time taken to do work of this nature is very greatly reduced.

According to Mr. Perron, there may be performed with this instrument in two days as much work as can be accomplished in five days when the ordinary method is used.—*Annales des Ponts et Chaussées.*

DETERMINATION OF ZINC IN ORES.

By A. Millot.

Various procedures have been suggested for the electrolytic determination of zinc. An acetic solution has been employed, or by preference a sulphuric, with the addition of ammonium sulphate. The deposit obtained is very adhesive, but the last traces of copper are very hard to separate. M. Beilstein recommends for the determination of zinc in brass, after separating the copper in a nitric solution, the precipitation of the solution by potassa, and the redissolution of the precipitate by potassium cyanide. This method occasions the platinum of the electrodes to be attacked, and the formation of a black deposit of finely divided platinum upon the negative pole. The author has previously proposed the use in this determination of an excess of caustic potash, which gives a very adhesive deposit of zinc, similar to that obtained with cyanide. With pure potassa entirely free from chlorides, the platinum electrodes are not attacked. The following process gives the best result with ores of zinc: Dissolve 2·5 grms. of the ore in 50 c.c. hydrochloric acid, adding while boiling a little potassium chlorate to precipite the iron. If much silica is present the solution is evaporated to dryness with a little hydrochloric acid. The liquid, when cold and diluted, is mixed with 100 c. c. of ammonia and 5 c. c. of a saturated solution of ammonium carbonate to precipitate the lead and the lime. When cold it is diluted to a half liter and filtered. We take 100 c. c. of the filtrate, corresponding to one half grm. of the ore, and containing from 0·2 to 0·3 grm. of zinc. There is added 1 grm. pure potassium cyanide, and the whole is placed in a precipitating glass. As a positive pole a cylinder of platinum wire gauze is used, and for a negative pole we place in the interior of the cylinder a platinum cone of the apparatus of M. Riche. The distance between the cone and the gauze ought to be a few millimeters. A current is passed through the solution answering to two Bunsen elements, or that of a Clamond's thermo electric pile of 150 elements. If the liquid contains 0·25 grm. of zinc there are precipitated in the first hour 0·15 grm.; in the second hour 0·075 grm. The last portions of the metal are more difficult to separate, but in nine or ten hours the precipitation is complete. The deposit is very adhesive; it is washed in alcohol, then in water, and the cone is dried and weighed. The zinc is then dissolved off

in hydrochloric acid, and the cone is dried and weighed anew. If the ore contains copper, it is deposited with the zinc. The deposit is redissolved in nitric acid, and the copper is precipitated by electrolysis in an acid liquid. Cadmium alone is determined along with the zinc, which is the case also in volumetric determinations. When it is present in the ore in notable proportions it must be removed by means of sulpureted hydrogen. The quantity of potassium cyanide must be exactly limited. If more is used than the weight given the metal will be deposited more slowly, and if the quantity is less the deposit is not adherent. This electrolysis in alkaline liquids occasions an attack of the platinum electrodes, and the formation at the negative pole of a black coating of finely-divided platinum, which is not removed by treatment with acids, but which changes continually the weight of the cone. The author avoids this inconvenience, due to the decomposition of ammonium hydrochlorate and the formation of nascent chlorine, by adding to the liquid to be electrolyzed 5 c. c. of a saturated solution of ammonium acetate. The acetate is decomposed by the current, and no chlorine is formed, so that the electrodes are not attacked. Ammonium nitrate answers the same purpose, but it delays the precipitation of the zinc. The results obtained in the absence of cadmium are absolutely exact.

THE RECOVERY OF SULPHUR FROM ALKALI WASTE (SCHAFFNER AND HELBIG'S PROCESS: A RECORD OF RECENT RESULTS.*

By ALEXANDER M. CHANCE.

INVENTED and applied in France by Leblanc, about the year 1790, and first introduced into England by Mr. Muspratt, in 1823, the manufacture of soda from common salt—generally known as the alkali trade—has gradually extended, until it has become the most important of all the chemical processes in Great Britain. Upon its production depend the manufacture of glass, soap, paper, and of many other articles of everyday use throughout the civilized world, while the quantity of raw materials required, and the labor and capital employed, render the alkali trade one of the leading industries of this country.

But apart from the interest which any such industry necessarily creates in a manufacturing country like England, there are special features incidental to the alkali trade which have, from the very outset, caused much more general attention to be bestowed upon alkali makers than they themselves have desired.

In transforming chloride of sodium (common salt) into carbonate of soda (common soda), by Leblanc's process, two by-products are produced, to deal with which, so as to prevent annoyance to their neighbors, and injury to adjacent property, has not only taxed to the utmost the ingenuity of the manufacturers themselves, but has also led to several special acts of Parliament. These two by-products are, as is well known, hydrochloric acid gas and alkali waste.

Since 1863, the condensation of hydrochloric acid gas has been rendered compulsory, and this acid, once a source of anxiety and loss, has, with the progress of chemical industry, gradually acquired considerable commercial value, and is now, in many districts, an article of primary importance to alkali makers, principally for the manufacture of bleaching powder and of chlorate of potash. In works managed with ordinary care, it is now easily kept under perfect control. The other by-product, namely, alkali waste, forms the subject of our consideration this evening.

By Leblanc's methods, the conversion of salt into soda, whether as carbonate or as caustic, necessitates several chemical operations. The decomposition of salt by sulphuric acid into sulphate, and the conversion of sulphate, by the addition of limestone and coal, into carbonate, involve, as every alkali maker knows, the entire loss of the sulphur and the lime, which thus become the chief constituents of the bulky, insoluble mass known as alkali waste. Of the two materials so lost, by far the more costly is sulphur, the cheapest supply of which comes to us from abroad in the shape of pyrites (principally from Spain); and it has long been felt that means ought to be found to prevent this enormous waste of sulphur.

According to the Board of Trade returns, as kindly supplied to me by Mr. William Smith, of Bristol, the following table shows the imports of brimstone and pyrites into the United Kingdom, during the years 1880 and 1881:

	1880.	1881.
	Tons.	Tons.
Brimstone....	46,896	40,561
Pyrites	657,867	542,046

We have thus a yearly average of 599,956 tons of pyrites for these two years, or in round numbers, say, 600,000 tons a year, for 1880 and 1881.

Let us now try to ascertain how much of the sulphur in this large quantity of pyrites is lost in alkali waste. According to the returns of the Alkali Association, we find that in 1880, 700,016 tons of salt, and in 1881, 675,099 tons of salt were decomposed, showing an annual average for 1880 and 1881, of 687,557 tons decomposed.

Now, as from the sulphur in one ton of Spanish pyrites about $1\frac{3}{4}$ tons of ordinary salt may be decomposed, we find the quantity of pyrites required to decompose 687,557 tons

to be $\frac{687{,}557}{1{\cdot}75}$ = 392,890, which figure therefore may

be regarded as indicating the yearly average quantity of pyrites used in 1880 and in 1881, in the United Kingdom, for the decomposition of salt in the alkali trade. But part of the sulphate of soda thus made was sold as sulphate, for glass making and other purposes; and an allowance must be made accordingly. Assuming that the sulphate so disposed of required for its production 42,890 tons (an outside figure) of pyrites, equal to about 84,000 tons of sulphate, we have, in round numbers, 350,000 tons of pyrites actually imported for the manufacture of soda (more than one-half of the entire imports) of which from 80 to 90 per cent. of the sulphur is lost in the alkali waste.

At the present price of sulphur in pyrites, namely, 6d. per ton per unit, of an average strength of 48 per cent., the value ex ship is 24s. per ton, irrespective of the cost of inland carriage.

The minimum money value, therefore, of the sulphur thus lost may safely be computed thus: 350,000 tons at 24s., equal £420,000, of which 85 per cent., or £357,000, represents the loss of the sulphur in alkali waste.

* A paper lately read before the Society of Arts, London.

These figures, estimated carefully, show the commercial importance of the question we are now considering. So long, however, as this loss of sulphur was shared by all makers of soda, and so long as no other method of manufacturing soda more cheaply existed, this loss, large as it is, fell rather upon the consumers than upon the producers of soda, and has hitherto been regarded by manufacturers as part of the cost of production.

Recently, however, the method known as the ammonia-soda process has been so successfully established on a large scale in England, that soda ash is being produced by it more, nay, much more, economically than by Leblanc's process, and thus the recovery of the sulphur from alkali waste, as a means of cheapening the cost of production by Leblanc's process, has become of vital importance.

The treatment of alkali waste is also forced upon the attention of manufacturers by the Alkali, etc., Works Regulation Act, passed in 1881, which came into operation on the 1st of January of the present year, by which alkali waste is, for the first time, made a subject of legislation.

Under section 6, it is enacted that "Alkali waste shall not be deposited or discharged without the best practicable means being used for effectually preventing any nuisance arising therefrom," and heavy penalties are attached to the non-observance of this requirement. By ceasing to have any alkali waste to deposit, alkali makers would, obviously, best comply with this provision; while, if they could at the same time profitably recover the sulphur and the limestone now lost, they might be enabled to compete succesfully with the ammonia-soda process just named.

The sulphur recovery process of Messrs. Schaffner and Helbig seems to offer a satisfactory solution of this question; but before we pass on to it, we must refer very briefly to other sulphur recovery processes, in order the better to appreciate fully its true value and importance.

So far back as 1837, the late Mr. Gossage took out a patent for decomposing tank waste by hydrochloric acid, or by carbonic acid, and for employing the H_2S thus generated for making sulphuric acid. But although, to quote his own words, "he devoted thirty years of his life and a fortune" to this object, he failed to establish a process by which the sulphur could be profitably recovered. Since that time, many other chemists have also devoted much time and thought and money to this object; but of the numerous methods suggested, and of the many processes patented, only three need here be mentioned, namely, those of Schaffuer, of Mond, and of Mactear.

According to Lunge (vol. ii., p. 652), the recovery of sulphur was accomplished nearly simultaneously (in 1861) by Schaffner and by Mond, who worked quite independently, and elaborated processes differing from each other in many details. The principle of each process, however, is the same, namely, the partial oxidation of the sulphur and calcium compounds in the tank waste, and the decomposition of the soluble compounds thus obtained by hydrochloric acid, by which a certain quantity of the sulphur originally contained in the alkali waste is recovered.

At the few works in England, where the recovery of sulphur from alkali waste has been carried out, the process adopted has been Mond's.

By the courtesy of Mr. Mond, I am permitted to publish the following results, which have been kindly furnished to me by the five firms in England who have used his process, designating, for obvious reasons, these firms by numbers and not by name:

Mond's Sulphur Recovery Process.—Results of the five firms using it in England.

Firms.	Total tons of sulphur recovered.	Percentage recovered of total sulphur in vat waste.	Tons of HCl used per ton of sulphur recovered.
1	6,690	30	$3\frac{1}{2}$ of 28° Tw.
2	1,500	27 to 30	4 of 25° "
3	3,200	*25 to 30	4 to $4\frac{1}{2}$ of 28° "
4	3,000	..	4 of 30° "
5	3,223	†17	not registered.

Total quantity of sulphur recovered=17,613 tons.

In Germany generally (according to Lunge) Mond's and Schaffner's processes are combined, and Schaffner himself still continues, it appears, to use his process at Aussig with considerable success, which process Mr. Mond affirms to be now practically identical with his own But these processes, although greatly in advance of all previous methods, fail to solve the alkali waste question, for the following three reasons among others:

1st. At the most, only 30 per cent. of the total sulphur in the waste has been recovered by them in England.

2d. A large quantity of hydrochloric acid is required for every ton of sulphur thus recovered.

3d. The waste, after treatment, still forms a bulky, troublesome deposit, although apparently no longer liable to cause a nuisance.

In striking contrast with these three drawbacks, will appear the advantages of Messrs. Schaffner and Helbig's process, by which at least 90 per cent. of the sulphur may be recovered, while no hydrochloric acid is required—and the residue to be deposited will eventually be barely one-fifth of the original bulk; probably, even much less.

But this paper, purporting, as it does, to treat of the sulphur recovery question in England, as a whole, would be incomplete if reference were omitted to processes by which sulphur can be recovered from the drainage from old waste heaps.

Schaffner's and Mond's processes, as just described—whether separate or combined—deal only with fresh alkali waste, as produced, day by day. The treatment of the drainage from old alkali waste heaps has been ably dealt with by Mr Mactear, whose process, as described by himself in a paper read before this society in May, 1878, is in operation on a large scale at Messrs. Tennant's Chemical Works, at St. Rollox, Glasgow, of which he is technical partner.

The experience acquired by him in working this process has led to certain modifications in the details, and the method now in use at St. Rollox is that patented in 1878, No. 885, in which a solution of bisulphite of lime is used, prepared from old waste oxidized chiefly to sulphites, and then treated with SO_2.

* Estimated.

† No record kept formerly; at present 17 per cent.

The chief advantage claimed for this modified process is that weak drainage liquors can be treated by it; and that, with the same plant, double the work can be done as compared with the original method; but a serious disadvantage is that it requires more hydrochloric acid per ton of sulphur recovered.

Mr. Mactear has kindly permitted me to state that already, by this process, over 14,500 tons of sulphur have been recovered at their St. Rollox Works.

Another mode of dealing with the drainage of old waste heaps, and, as it seems to me a much simpler and more economical one, is that patented by M. Pechiney, and now in use at his works at Salindres, in France.

By an identical method, applied during the investigation of this subject by our chemist, Mr. Dryden, in complete ignorance of M. Pechiney's operations, the whole of the drainage of our waste heap is being satisfactorily dealt with at our alkali works at Oldbury, near Birmingham. It consists simply of oxidizing the drainage liquors in iron tanks, by means of a current of air and steam produced by a Koerting's injector, until the oxidation reaches the point when, by adding HCl, neither H_2S nor SO_2 is given off. By then adding HCl the whole of the sulphur is precipitated as impure sulphur, which is dealt with in the ordinary way, and a clear solution of chloride of calcium is run off. Fuller information concerning this simple and effective method of dealing with the drainage of old heaps will be found in Mr. Weldon's paper, read before the Society of Chemical Industry in London, in January last, and in the discussion which followed. Any communications respecting it should be addressed to Mr. Walter Weldon, who represents M. Pechiney's interests in the patent in this country.

This rapid review of the main features of the principal processes actually used in England for dealing with alkali waste, and of the results obtained, will be of service, in enabling us better to realize the great advance established by Messrs. Schaffner and Helbig's process, and to appreciate the influence it is likely to exert upon the future of the alkali trade.

SCHAFFNER AND HELBIG'S SULPHUR RECOVERY PROCESS.

Although patented in England in March, 1878, this process did not become known to us until its publication *in extenso* in Professor Lunge's admirable and exhaustive treatise on the Alkali trade, issued in 1880, to which source, also, Dr. Angus Smith is indebted for the extracts given in his sixteenth annual report. From Professor Lunge's most valuable book, and from the original specification itself, full information can be obtained by all who desire to study the origin and the theory of this deeply interesting process.

To-night we have to consider, briefly, the chemical reactions and combinations discovered by Messrs. Schaffner and Helbig, the results obtained by our firm, as pioneers of this process into England, together with such other details and information as practical experience may have suggested.

Three distinct chemical reactions, involving three separate and distinct operations, constitute this process as originated by its distinguished authors, Messrs. Schaffner and Helbig.

I. The decomposition of the calcium sulphides in the alkali waste, by magnesium chloride, by which the sulphur is liberated as H_2S, *without being diluted with other gases.* This reaction is stated thus:

$$(1.)\ CaS+MgCl_2+H_2O=CaCl_2+MgO+H_2S.$$

II. The reconversion of the magnesia (MgO) thus formed into chloride of magnesium, and the recovery of the calcium from the $CaCl_2$, in the form of carbonate of lime, by the action of carbonic acid gas, thus:

$$(2.)\ CO_2+MgO+CaCl_2=MgCl_2+CaCO_3.$$

III. The recovery of the sulphur from the H_2S, by precipitating the S by means of SO_2 thus:

$$(3.)\ 2H_2S+SO_2=3S+2H_2O.$$

Let us now consider these three operations in their order.

The first operation, that of the decomposition of the calcium sulphides by the $MgCl_2$, is very readily accomplished, if care be taken that the solution of $MgCl_2$ be of sufficient strength, and be present in excess A solution of a minimum strength of 30° Twaddell works advantageously.

Analyses of vat waste show that the sulphur present is almost entirely in the form of sulphides when the waste is thrown out of the vats, and that by exposure to the atmosphere, the sulphides gradually become oxidized into hyposulphites, which are not acted upon by $MgCl_2$.

It is therefore essential that the vat waste should be used, and be taken from the vats to the decomposers, without loss of time, as the fresher the vat waste used, the larger is the quantity of sulphur recoverable. Of the total sulphur in the vat waste, we have found that from 90 to 95 per cent. may be thus recovered, the balance, from 5 to 10 per cent. being lost, partly in the hyposulphites, etc., of the vat waste (which are not acted upon by the $MgCl_2$), and the remainder in the conversion of the H_2S into its commercial product. Great care, both in the construction of the plant and in the manipulation, is of course essential to guard against escapes of this highly dangerous and offensive gas, H_2S.

As $MgCl_2$ has not any action upon the undecomposed carbonate of lime present in the waste, the H_2S given off is *perfectly pure*, except as regards a certain quantity of steam, which is readily separated by means of condensation. The purity of the H_2S is one of the special features of this process, and contributes—as will be seen when we consider the third operation—in no small degree to its success.

The second operation, known as the carbonating process, by which the magnesium chloride is recovered, and carbonate of lime is obtained, is of the highest importance. It was in this operation that appeared to Mr. Weldon (to quote his own words) "the weak point in this very remarkable process," and to the impression left upon his mind by some experiments of a similar nature, made by himself some eleven or twelve years ago, he attributes in part the fact that although he brought it under the notice of many of the principal alkali makers in England, as Dr Schaffner's representative, yet as "he could not tell them, either that Dr. Schaffner was himself performing the process on an industrial scale, or that he could regard the industrial practicability of this operation as being as yet absolutely established, none of them cared to do more than discuss the matter."

Nothing, therefore, was done in this country with this process until, as already stated, we first learned of it from Lunge's book, and being in happy ignorance of Mr. Weldon's misgivings we took steps to try it for ourselves. We failed at first to obtain satisfactory and complete results in consequence of our power of pumping CO_2 being insufficient, but when we were able by means of a powerful compressor, specially constructed for the purpose by Messrs. Tangye, of Birmingham, to force CO_2 into the carbonators in a steady stream *under pressure*, we found that this operation also was completely successful.

The carbonic acid gas used by us is supplied from a lime-kiln, heated by coke, the lime being used in our caustic soda process; the strength of the CO_2 gas thus obtained varying from 15 to 23 per cent. As yet we have not tried the flue gases from the black ash furnaces, but if the CO_2 thus produced is not too dilute, we hope eventually to use this source of CO_2 in this operation. The $MgCl_2$ thus recovered is used over and over again, but as the traces of soda left in the waste are converted into chloride of sodium, it will happen that each successive batch of recovered $MgCl_2$ will contain a little more of the NaCl so formed; a source of embarrassment, which, though slight and unimportant at first, will gradually have to be provided for. The carbonate of lime thrown down is collected on filters, and carefully washed, in order to recover all the $MgCl_2$; these washings, being necessarily dilute, require to be concentrated by means of evaporation. The carbonate of lime itself will, to a large extent at least, be available for black ash mixings; not entirely, however, as some part may, for the present, have to be treated as a by-product, and be put aside, as it remains to be proved whether the impurities of silica, alumina, etc., etc., introduced by the black-ash operations, will not, as they accumulate, render the recovered carbonate unfit for mixing purposes.

To what full extent, therefore, the recovered carbonate of lime will be available for black-ash making is at present a mere matter of conjecture; perhaps it may be used four or five times, and the next batch have to be put aside, but this part of the process offers no serious obstacle to its success. My own thoughts turn in the direction of compressing the carbonate of lime thus put aside, which may not be pure enough for mixing purposes, into bricks, and then burning these bricks instead of limestone in the lime-kiln, thus obtaining the carbonic gas required, and selling the slightly impure lime so made to lime merchants, for building purposes.

The large towns of Liverpool, Newcastle, Glasgow, Birmingham, and Bristol, which are in close proximity to the at Oldbury, and, as we believe, for the first time, practically accomplished this operation on a large scale, it may be of interest to give some details of the process.

After the steam which is given off with the H_2S in the decomposer has been removed by means of cold water in a condensing apparatus, the dry H_2S is conveyed along a 4-inch cast-iron main, protected by hydraulic seals, to prevent the possibility of "lighting back," to a special burner, consisting of a cast-iron box, also water sealed, out of which a series of one-inch gas pipes pass into a brick oven, through a cast-iron plate, perforated for the admission of air. The H_2S gas is lighted as easily as ordinary coal-gas, and burns quite freely, giving off considerable heat, and producing, as is well known, by its combustion, just sufficient water for forming H_2SO_4 as shown by the equation, $H_2S+4O=H_2SO_4$, and thus saving a great deal of steam. The niter pots are placed in the flue at one or other of several potting doors, more or less distant from the burning gas, according to the increasing or decreasing supply of H_2S from the decomposers.

The oil of vitriol thus produced is of great purity, quite free from arsenic, and, upon concentration, yields rectified oil of vitriol fit for every purpose. We show samples tonight of this acid. So satisfied are we with these results, that we are making arrangements to burn the H_2S in connection with a Glover's tower, so as to derive the economy of niter, of fuel, and of labor, due to that apparatus. If by a rough and ready burner, such as described, working only at intervals, we succeeded in obtaining satisfactory results, it seems certain that alkali makers will turn their attention, by preference, to this means of utilizing the sulphureted hydrogen.

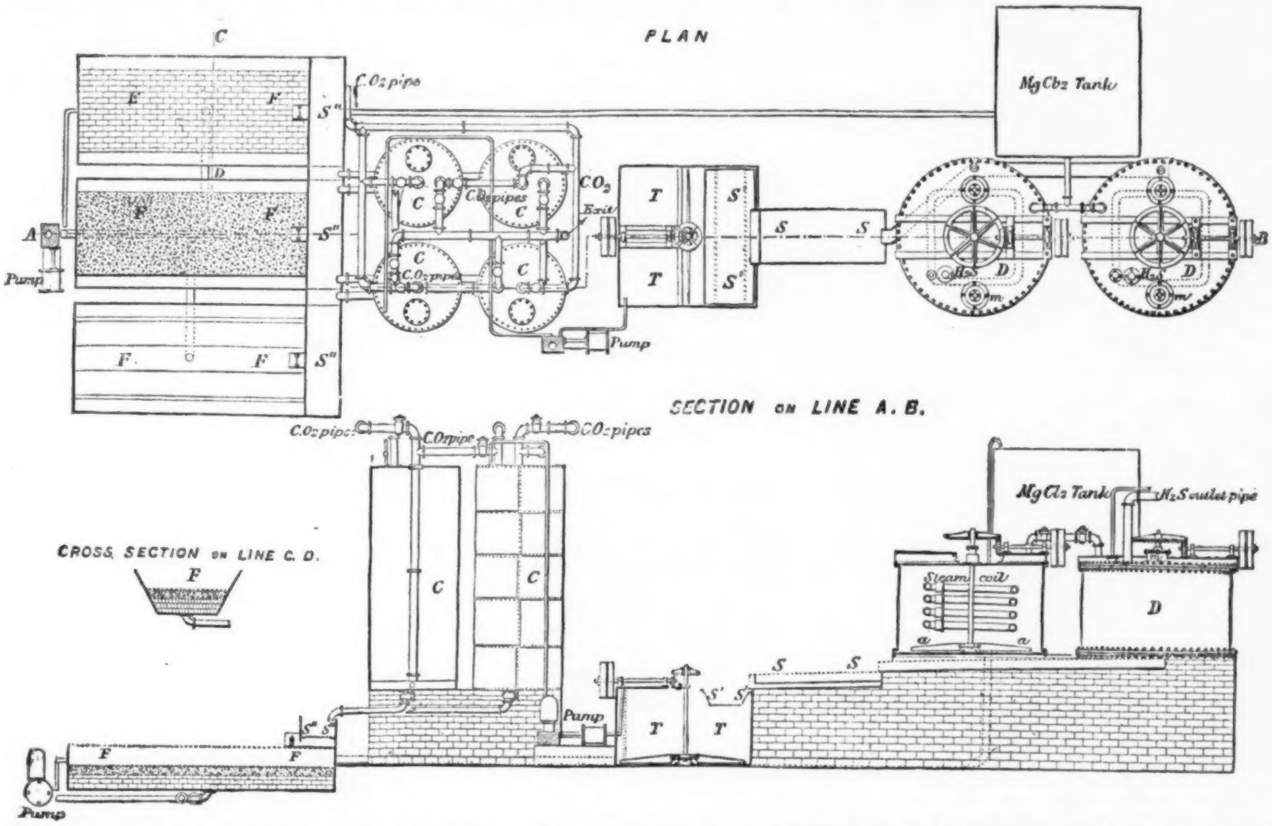
We have now seen that the chemical combinations discovered and applied by Messrs. Schaffner and Helbig do fully realize the conditions claimed for them by their distinguished inventors—that from 90 to 95 per cent. of the sulphur in the vat waste may be recovered in a commercial form; that practically the whole of the calcium compounds tion has hitherto been chiefly, nay, almost exclusively, directed to two points, namely:

1st. The direct manufacture of sulphuric acid, by burning the H_2S in vitriol chambers, in which we have been completely successful; and

2d. To the precipitation of the carbonate of lime, and the recovery, in the carbonators, of the $MgCl_2$ by means of CO_2.

This operation, as already stated, is found to be completely successful from a chemical point of view, and the reactions claimed for it in theory have been fully realized in practice. But our experimental plant, erected temporarily, and not with a view to permanency, has, as we fully expected, been the means of educating us, so that when we proceed to erect new and more extensive plant, for the treatment of our alkali waste, we shall know more precisely what to keep, and what to alter.

Several defects in our plant have caused losses of $MgCl_2$—losses thus solely due to mechanical causes—but these defects have, unfortunately, rendered worthless our results, as to the probable unavoidable loss of $MgCl_2$. The principal source of loss, however, has been due to our vacuum filters, and to our incomplete means of washing the carbonate of lime, which forms a precipitate so considerable in its moist state—exceeding in fact the bulk of the original vat waste itself—that a little $MgCl_2$ left behind in each ton would amount to a material total loss upon the whole quantity. Pressure filters, fitted with suitable washing apparatus, seem to offer the solution of this difficulty. During the last few days I have made inquiries from those who have had practical experience of filter presses, as to their probable value for this purpose, and from the information I have obtained, I entertain but little doubt that the use of filter presses will be crowned with success. The results of our last week's working—ending on Saturday, 6th May—are very encouraging. The loss of $MgCl_2$ amounted to 4·1 per cent., equal to 2 cwt. 1 qr. 22 lb. per ton of S recovered, besides about 40 lb. of calcined dolomite per



EXPERIMENTAL PLANT FOR SCHAFFNER AND HELBIG'S SULPHUR RECOVERY PROCESS, AS WORKED AT THE ALKALI WORKS OF MESSRS. CHANCE BROTHERS OLDBURY, NEAR BIRMINGHAM.

principal centers of the alkali trade, would seem to offer ample outlets for all the lime so produced, if it were not pure enough for chemical purposes.

The third operation deals with the H_2S given off in the decomposers, and converts it into commercial products. Messrs. Schaffner and Helbig propose to deal with it, by precipitating the S by the reaction, as already stated:

$$2H_2S+SO_2=3S+2H_2O$$

This operation is fully described by Lunge, vol. ii., page 690, and the difficulties to be overcome, and the means by which the distinguished originators of this process overcame them are clearly set forth in the same volume, pages 645 to 648. Messrs. Schaffner and Helbig have proved that all the sulphur can be obtained in a granular, easily separable form, and without any loss by polythionic acids, if the gases are brought into contact, not with water, but with solutions of such salts as calcium chloride, magnesium chloride, sodium chloride, etc.

The operation just described has been successfully worked, on a manufacturing scale, at Dr. Schaffner's works at Aussig. We had hoped to have been honored with Dr. Schaffner's presence here to-night, and to have heard from him further details of this very interesting process for extracting sulphur, as such, from H_2S. But, in his absence, Mr. Weldon gives me to understand, that Dr. Schaffner recovered about two cwt. of free sulphur per day for about six months.

From the outset, however, of our own investigation of Messrs. Schaffner and Helbig's process, we were struck with the facility with which the *pure* H_2S, so produced, burns; and we, therefore, proceeded to try whether it might not thus be converted directly into sulphuric acid in vitriol chambers. The direct production of sulphuric acid by such means would, obviously, be very advantageous to alkali makers, who would thus recover from their alkali waste the sulphur in the very form in which they need it, besides dispensing with any large outlay for special plant. Having, are also recovered, principally as carbonate of lime; and that the reagent by which these remarkable results are obtained—namely, $MgCl_2$—is itself recovered, with the exception of the *unavoidable losses due to the manipulation of the process.*

In this last sentence lies the key to the success or to the failure of this beautiful process. $MgCl_2$ is valuable—far too costly at present to admit of any large measure of waste being disregarded. It may—it probably will—become cheaper and cheaper as its uses increase, and fresh sources of supply are brought to light; but meantime, its consumption must be minimized, if this process is to be adopted with all the bright prospects which it opens out.

You will therefore ask, and I will honestly endeavor to answer, as candidly as possible, the crucial question—What have these losses been, and what is the probable prospect of loss of $MgCl_2$ in this process?

But before entering upon this question and bringing this paper to a close, I must invite your attention for a few moments to the model submitted to-night of the experimental plant which we have ourselves been and still are using.

Let us now enter upon the consideration of the very important question of the unavoidable loss of $MgCl_2$.

So far as we have been able to determine, we have satisfied ourselves that chemically the combinations are complete, and that there do not appear to be any losses whatever of $MgCl_2$, except those due to manipulation. According to Lunge, vol. ii., page 695, the loss of $MgCl_2$, unavoidable in working on the large scale, is 5 or 6 per cent. Presumably, Professor Lunge obtained these figures from Messrs. Schaffner and Helbig, and if these figures can be shown to be the result of continuous working on a large scale, then the commercial success of this process is undoubtedly assured. For our own part, however, we are not, to-night, in a position to submit any actual figures as to the probable limits within which this loss can be confined. As pioneers of this process into England on a manufacturing scale, our atten- ton of vat waste treated. But the analyses of several samples of the lime mud made last week showed that nearly the whole of this 4·1 per cent. of the $MgCl_2$ was present in the lime mud, so that had filter presses been used, and the bulk of this $MgCl_2$ been thus recovered, our loss of magnesium would have been almost confined to the dolomite added to the carbonators.

This perfectly candid confession of our imperfect manipulation of this important portion of the process should not in any way deter others from embarking in it, as it will certainly not deter us from continuing to work upon it. At present we are busily engaged in doubling our plant, and in devising suitable filtering apparatus—the best possible proof of our opinion of the value of this most comprehensive method of dealing with alkali waste.

To the members of the Society of Chemical Industry, before whom, in London, Mr. Weldon first publicly directed general attention last January to this process, I promised, in the discussion which ensued, to submit the commercial results of our experiments—a promise which I look forward with much pleasure to fulfilling without any unnecessary delay. But for practical purposes and to be of any permanent value, figures of this kind should be based upon results obtained during an extended period, and from a sufficient quantity of material employed.

Meantime, the invitation which I had the honor, most unexpectedly, to receive from the Society of Arts, to read this paper to-night, has afforded an excellent opportunity, to many interested in this subject, to learn precisely what has been and what still remains to be done.

For my own part, I should much have preferred that one of the recognized leaders of the alkali trade had been in my place to-night, and I in his; but I am paying the penalty for the boldness which tempted me to try Messrs. Schaffner and Helbig's process, while others held aloof. The attractions of this beautiful process are still to me as great as ever. To recover, henceforth, at least nine-tenths of the sulphur now lost in the vat waste, instead of at most three

tenths, as had been occasionally recovered hitherto; to recover it without the use of any hydrochloric acid whatever; to become to this large extent independent of foreign sources of supply of sulphur; and to render the deposit of alkali waste no longer necessary, are advantages too substantial to be lightly disregarded in the present state of the alkali trade. Messrs. Schaffner and Helbig have opened up entirely new ground—have suggested entirely new possibilities. Their process may be, it probably will be, ere long, rendered more easily practicable by the further inventions of its illustrious authors themselves, and if Mr. Weldon, their distinguished representative in England, will disclose to us to-night the details of the more perfect process which be stated last January was soon likely to be announced to the world by Messrs. Schaffner and Helbig, he will add yet one more to the many obligations under which he has placed alkali manufacturers, not only by his own remarkable inventions, but also by directing their attention to the inventions of eminent manufacturers abroad. As it is, the recovery of sulphur from alkali waste seems at last to be within a "measurable distance" of accomplishment, and to Messrs. Schaffner and Helbig belongs the credit of having originated the beautiful process which promises a new lease of life to the manufacture of alkali, as invented by Leblanc.

DISTINCTIONS BETWEEN ORGANISMS AND MINERALS.

Certain recent investigations have shaken if not altogether overthrown one of the most striking distinctions between the inorganic and the organic world. Suppose we take up one of those bodies in which dead matter is individualized, *i. e.*, a crystal. We perceive at once that its surfaces are planes, bounded by right lines.* We may, by grinding and rubbing, bring such crystals into rounded forms, and nature may effect the same if the crystals lie in the bed of a rapid river, or on the shore of the sea. But these forms are essentially artificial, and are never assumed when inorganic matter is left to crystallize. On the other hand, if we take an animal or a plant and examine its shape, we find that, save in some of the lowest groups, it has exclusively rounded surfaces, spherical, spheroidal, ellipsoidal, cylindrical, etc., and that its outlines are curves. This distinction between the living and the lifeless is so striking that it was once proposed to view the development of animals and vegetables as a process of curvilinear crystallization, peculiar to certain kinds of matter when placed under proper conditions. The immense mathematical difficulties involved were the reason why the idea was never worked out.

Again, if we break, cut in pieces, or otherwise dissever a mineral and an organism, we find that their respective differences of structure are not confined to the outer surface. The disintegrated particles of the mineral body are each solid; each, if cut or broken, consists, within and without, of the same kind of matter. We may find in minerals, *e. g.*, asbestos, a fibrous structure, but such fibers are not tubular, and never contain either a fluid or any solid body differing in composition or in structure from the outside layers. In the organic world all this is otherwise. If we examine the intimate structures of the plant or the animal, we find tubes, sometimes hollow, sometimes containing a fluid, or sometimes a solid matter differing in its nature from the inclosing walls. We find also round or oval vesicles known as cellules and generally containing fluid matter. These well-known contrasts are presented here in the briefest and most sketchy manner, not as being in themselves novel, but as necessary to be borne in mind for the understanding of what is to follow.

In February, 1878, M. Georges Fournier, of Paris, performed, in presence of Mr. W. Crookes, F.R.S., and of the present writer, some most remarkable experiments. By mixing together certain inorganic salts, he produced pseudo-organisms, which, in form and structure, might easily have been confounded with certain cryptogamous plants by any one who was not acquainted with their origin. In the belief that M. Fournier was continuing his experiments, we considered it a duty not to make his results known in a premature and necessarily incomplete state. It was, therefore, with regret and surprise that we saw in the *Comptes Rendus* for January 2, 1882, a memoir by D. Monnier and C. Vogt, a translation of which follows:

"Figured elements presenting all the characteristics of form belonging to organic elements, such as cellules, simple and with porous channels, tubes with sides, with septa, and with heterogeneous granular contents, may be produced artificially in an appropriate liquid by the joint action of two salts, forming by double decomposition one insoluble salt, or two such. The one of these salts must be dissolved in the liquid, while the other must be present in a solid form.

"These organic elements, cells, tubes, etc., may be produced either in a liquid of organic or semi-organic source, such as the saccharate of lime, or in an absolutely inorganic liquid, *e. g.*, silicate of soda. Hence there can be no longer any question of distinctive forms characterizing inorganic bodies on the one one hand and organic on the other.

"The formation of such pseudo-organic figured elements depends on the nature, the degree of viscosity, and the concentration of the liquids in which they are produced. Certain viscid liquids, such as solutions of gum arabic, or of zinc chloride, yield nothing of the kind.

"The form of these pseudo-organic products is constant with reference to the salts employed, as constant as any crystalline form of minerals. This characteristic form is so well maintained that it may even serve for the detection in mixtures of a minute proportion of a substance.

"The form of the artificial pseudo-organic elements depends principally on the acid which enters into the composition of the solid salt. Thus the sulphates and the phosphates produce tubes, while the carbonates give rise to cellules.

"With some exceptions, such as copper, cadmium, zinc, and nickel sulphates, the pseudo-organic forms are only produced by means of substances which are found in real organisms. Thus the saccharate of lime produces organic forms, while those of strontia and baryta do not.

"The artificial pseudo-organic elements are enveloped in true membranes possessing a high degree of dialyzing power, and giving passage merely to liquids. They have heterogeneous contents, and produce in their interior granulations arranged in a determined order. They are, therefore, in form and constitution absolutely similar to the histological elements of organic beings. It is probable that the inorganic elements contained in protoplasm play a certain part in the constitution of the figured organic elements."

The close similarity, both of the means employed and of the ends reached by these authors, and by M. Fournier, is very interesting. Silicate of soda was one of the compounds used by M. Fournier, and salts of nickel played a prominent part in some of his most striking results. After having thus vindicated the claims of my friend, I must attempt to show some of the bearings of this discovery.

It must be admitted that the structures produced are merely pseudo-organisms. They manifest none of the phenomena of life. They do not take in, assimilate, and excrete any kind of matter. They do not propagate. Nor does it appear that if carefully preserved under constant conditions they might not continue to exist for an absolutely indefinite time. They have, therefore, no vital cycle—no periodicity.

Nevertheless we must note the points in which they seem to link the organic and the inorganic world together. As MM. Monnier and Vogt urge, one of the characters by which mere lifeless matter was till yesterday differentiated from the living organism is wiped out. There are no longer any distinctive forms by which we may distinguish the two great classes. Here a new thought will suggest itself to every reader: these pseudo-organisms have, so far as we know, been obtained experimentally only by M. Fournier, and by MM. Monnier and Vogt. But is it not very possible that such structures might be produced without human intention and interference in what we call an accidental manner? Might they not, considering the large proportion of silica which they contain, become preserved for ages, and continue to display pseudo-organic features? Suppose we find in a rock certain structures exhibiting apparently organic cells, are they the remains of true organisms or of pseudo-organisms? This consideration—at least till it has been further studied—is not without its bearing upon such questions as the organic or mineral nature of the structures found in meteorites, and, *e. g.*, of *Eozoon Canadense*.

It is highly significant that, with certain exceptions, the rationale of which may become clear on future scrutiny, only those chemical elements which occur in natural organisms are able to take part in producing these pseudo-organisms. Chemists fully recognize the close analogy which exists between lime, strontia, and baryta. Yet while the saccharate of lime lends itself to organic formation the corresponding salts of strontia and baryta are excluded. This consideration is of grave import. It would seem to follow that certain chemical compounds are capable and naturally tend to produce organic structures, cells, tubes, etc., under certain conditions, just as under others they give rise to crystals. But MM. Monnier and Vogt have gone even further, and have been able to specify the classes of structures which different compounds may form. They state that sulphates and phosphates originate tubes, while the carbonates give rise to cells. May not these facts have their meaning, to be traced out, perhaps, in some country where biological research is free? May they not throw light upon the functions of different classes of salts in the process of nutrition? Has the attempt been made to quicken these pseudo organisms into a higher stage of existence by the application of varying conditions of atmospheric pressure and composition, of light, temperature, etc.? At any rate, these growths seem to be, from a structural point of view, a transition stage between the unequivocally inorganic and the decidedly organic and vitalized. It is conceivable, at least, that such has been the path taken by nature.

Apart from all special scientific considerations, the experiments of MM. Fournier, Monnier, and Vogt have a philosophical value as confirming the principle of continuity.

We must take the liberty of here calling attention to certain researches which, though not in direct connection with the experiments of M. G. Fournier and of MM. Monnier and C. Vogt, serve in some degree to lessen the gap between the organic and the inorganic world, or at least to throw light upon the cause of life from a chemical point of view.* Our readers are, of course, aware that sixty years ago all organic compounds were supposed to be due to the action of a distinct vital force, and to be quite incapable of artificial production. In 1828, Woehler succeeded in constructing urea from dead matter. Since that time not a few organic compounds, formerly obtained only from plants and animals—such as alizarine, indigo blue, vanilline—have become laboratory products. But chemists have failed in the synthesis of the more characteristically vital compounds, such as albumen. Further, till the year 1875, the idea of a chemical distinction between living and dead protoplasm was not even conceived. Prof. Pflüger ("Pflüger's Archiv," x., p. 251) advanced the opinion of a necessary chemical difference between protoplasm in these two conditions. It may be well here to remark, for the benefit of such readers as are not conversant with modern bio-chemical research, that protoplasm is not an abstract idea or a mere theoretical body. It is a substance which can be obtained from certain plants—*i. e.*, *Ethalium septicum*, and submitted to the investigations of the chemist and the microscopist. The idea was taken up by HH. O. Loew and Thomas Bokorny, of Munich. The former of these chemists, in establishing a rational formula for albumen, was struck by the circumstance that it contained a number of aldehyde groups immediately bordering upon amide groups. Such groups, according to modern chemical philosophy, must be distinguished by intense atomic motion. Hence, argued Herr Loew, this motion constitutes life, while the respective displacement of the aldehyde and amide groups, and the necessary cessation of the atomic motion, involve death, it may be of a mere molecule of protoplasm, or of a larger portion, or of the entire animal or plant.

Now, so far we have to deal merely with a theoretical assumption. This point requires, therefore a little further explanation. The methods of the astronomer are utterly unintelligible to the majority even of educated men. But when an astronomer on theoretical grounds predicts the existence of a hitherto unseen planet, and another, turning his telescope to the spot, discovers it there as foretold, the public is forced to admit that the hypotheses of astronomers deserve a great degree of confidence. Very similar is the case with the speculations of the chemist. No man has seen a molecule, much less an atom. No man can say on the direct evidence of his senses, that in a molecule the atoms are arranged in this or the other manner. Nor has any one witnessed the more or less rapid vibration which the atoms in a molecule, or the molecules in a compound body, are inferred to undergo. But when we find chemists setting out from these assumptions come not by chance but intentionally to such results as the formation of artificial indigo, they are entitled to claim for their assumptions at least provisional acceptance.

HH. Loew and Bokorny, however, were not content without testing their supposition experimentally. They found that living protoplasm has the power of reducing silver from a very dilute alkaline solution, while in dead protoplasm this property is wanting. By dint of a long course of investigation they determined that this reduction could be due merely to the presence of the aldehyde groups in the protoplasm while living. In living protoplasm the aldehyde groups of each molecule are brought in immediate proximity with the amide groups of the next, and thus a considerable intensification of the vital molecular motion ensues. But with increasing complexity and motility follows increasing instability. Apparently trifling agencies displace the molecules and their action ceases. During every such molecular displacement, which is in fact a combustion, heat is liberated. Hence the rise of temperature in fevers, and that which occurs upon death. On the other hand, when lifeless albumen is assimilated and converted into the protoplasm of a living cell, heat becomes latent. The absorption of oxygen, and the formation of carbonic acid, in short, the whole process of respiration, becomes intelligible, since it is admitted that an increase of molecular motion promotes chemical action and consequently oxidation. Vital force, Herr Loew considers to be, in short, reducible to the tension of the aldehyde groups ultimately due to electric differences. Life is the total result which the protoplasmic structure yields by means of such vital force. Space does not allow us to reproduce here the experimental evidence which the authors here set forth in support of their theory. They trust that at any rate the first step has now been taken toward explaining the numerous mysteries which appear in the manifold functions of protoplasm. Even the cardinal problem, the first origin of protoplasm upon our earth, seems to them only a question of time.

While wishing the authors good speed in the arduous task they have in hand, and while admitting that they have laid down a fair working hypothesis on the nature of life, which must stand or fall by its results, we wish to point to one difficulty. They appear to regard albumen and protoplasm as substantially identical in composition. Now, according to the analyses of Reinke, referred to in the *Journal of Science* for 1881, p. 182, protoplasm contains scarcely 30 per cent. of albuminous matter, and contains upward of forty proximate principles. The question now arises whether all these principles are truly components of the protoplasm molecule?—*Journal of Science.*

* The partial exception in case of the diamond—carbon—is insignificant.

* Die Chemische Ursache des Lebens, Von Oscar Loew und Thomas Bokorny. München: J. A. Finsterlin.

THE ELECTROLYTIC COMPANY, LONDON.

The new works of this company in Charlotte street, Blackfriars, S. E., are now in an advanced state, and all kinds of electro-deposition is being carried on under the able superintendence of Mr. William Elmore, of 91 Blackfriars road, the well-known introducer of nickel plating into this country. By means of large baths, 24 feet long by 6 feet deep, Mr. Elmore is able to deposit copper or nickel upon rough castings or polished iron objects of any size or weight. It is becoming more and more the custom to cover metal work exposed to the atmosphere, or to water with copper or nickel, and hence we find that the Electrolytic Company are engaged in coating such articles as engine boiler tubes, lamp posts, hydraulic rams, the covers of cylinders, the parts of heavy iron structures, and pieces of ordnance. Hydraulic rams are covered with a $\frac{3}{16}$ in. thickness of copper, which is turned down to $\frac{1}{8}$ in., and the copper surface, which is sufficiently hard, works very smoothly in the cylinder and does not oxidize. Moreover, when reduced in size by wear, it can readily be built up again to its old dimensions by the electro-deposition of more copper on it. Boiler tubes are coated exteriorly with $\frac{1}{8}$ in. thickness of copper, which is turned down to $\frac{1}{16}$ in. The sulphate of copper bath of Mr. Elmore is specially prepared to give a flawless and regular coating of hard pure copper, and some of the specimens of art metal work, such as stove and door panels, are singularly beautiful.

Nickel, by its hardness and its resistance to the attack of sulphurous gases, is preferable to silver as a plating for many implements and utensils, especially such household articles as sewing machines, dish covers, scissors, and so on. It is also convenient for bicycle frames and saddlery hardware. Mr. Elmore employs a solution of the double sulphate of nickel and ammonia for the nickel bath. The solution is fortified by electrodes of nickel, weighing half a hundredweight each.

In all the baths the strength of current is regulated by means of a series of resistance bars of copper at the ends of each bath, and the density of the liquid is kept equal throughout by means of a rotary stirrer. Brass is also deposited upon ornamental iron work, fenders, locks, and steel goods, as well as upon lead, pewter, zinc, tin, and Britannia metal. Tin is deposited on bright steel or rough iron, and the interiors of copper utensils; all kinds of electrotypes for printing purposes; and the most delicate natural objects, such as ferns, flowers, insects, are electroplated with copper and the nobler metals at the Electrolytic Company's works. The ordinary method of backing up an electrotype with lead, is now giving place partially to the practice of depositing tin upon it; and copper electrotypes are also faced with steel or nickel to protect the surface from the action of printing inks, and at the same time preserve the clear brilliancy of vermilion and other mercurial colors used in printing. In short, the Electrolytic Company occupy the whole field of electro-deposition, and also supply the necessary plant for export. The Elmore dynamo-electric machine is specially adapted for the work because of its continuous current and low internal resistance, and it is gradually becoming largely introduced.

These machines are made on the premises in Charlotte street, and ten of large size are now being made for a firm in Swansea to deposit pure copper for electric cable purposes; each machine of this class is capable of depositing 500 lb. per day of pure copper from the sulphate. A smaller machine of the same kind, known as the 15 in. machine, deposits 200 lb. of copper in a day; and there is a still smaller pattern for lighter work. Messrs. Cassell, Petter & Galpin, Messrs. Waterlow & Sons, Messrs. De la Rue & Co., among others, have adopted Mr. Elmore's machine for electroplating purposes, and the last-named firm have found it very satisfactory in the preparation of the dies for postage stamps.

Before leaving the subject, we may mention that Mr. Elmore has devised an ingenious tell-tale, whereby the weight of gold or silver deposited on an article is indicated to the person in charge by the ringing of an electric bell in his office. When the proper weight of metal has been deposited the balance completes an electric circuit and the bell rings; while at the same time the current for that particular bath is cut off, and the process of deposition terminated.—*Engineering.*

APPLICATIONS OF ELECTRICITY TO RAILWAY TRAINS.

In the management of railways, electricity has been applied principally to signals, telegraphic communications, and, in a word, to the fixed *materiel*. This is not because the idea has never occurred to employ it for communications between the moving train and intervening stations; for complete projects (one of which dates as far back as 1853) have been devised for keeping in this manner locomotives in constant communication with the points of surveillance. But these have never been applied except experimentally, either because companies have not judged it proper to go to the expense, or because they have believed there were (as, to a certain extent, there are) serious difficulties in the way of keeping up the communication. The most recent application in this line is that of the Ceradini automatic block-system.

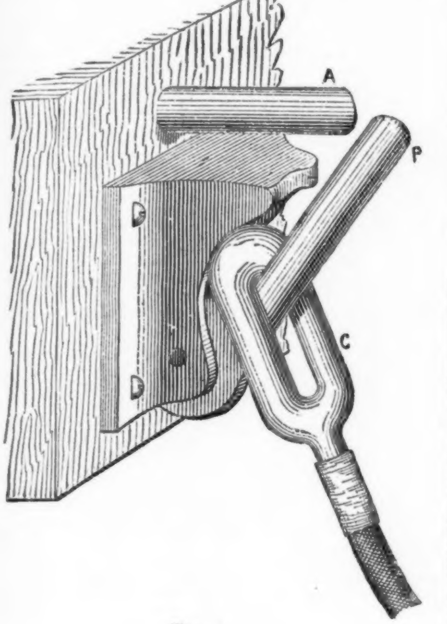


Fig. 1.

The application of electricity to communications between the different cars of a train, called *inter-communication*, presents fewer theoretical difficulties, and yet it was not till toward 1853 that attention began to be paid to it. At that time, in consequence of the murder of Counsellor Poinsot by Jud, committed on the Paris-Lyons-Mediterranean line, the government required all railway companies to put at the disposal of passengers some means of communication which should permit of giving an alarm in the baggage-car, and of calling the employes while the train was under way.

Electricity was naturally indicated for such a purpose, and recourse was finally had to it, not, however, it is true, until several mechanical processes had been tried. But that was as might have been expected, seeing how little confidence companies have, and especially had, in electrical action.

The system which was successful, and the principles of which are still predominant in applications of this nature,

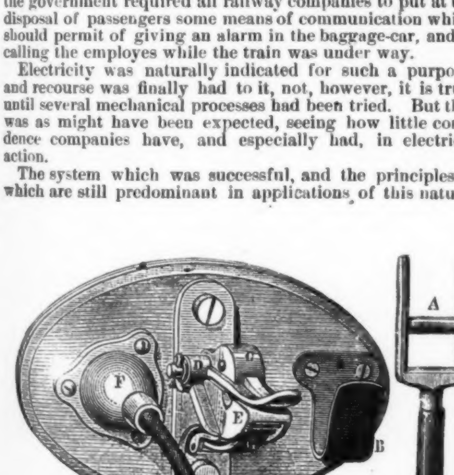


Fig. 2.

was that of Messrs. Tesse & Prudhomme. It has already been described, but we believe it necessary to recall the arrangements of it in order to make the difficulties that had to be overcome better understood. And such difficulties are, in fact, genuine ones, not from a theoretical but from a practical point of view.

Let us define the object that has to be attained. It is necessary that, from any compartment whatever of the train, there may be actuated two alarm-bells, one of these being located in the front baggage-car, and the other in the rear. Moreover, these two alarms must be at the disposal of the employes in the baggage-cars, so that, if necessary, signals may be sent from one end of the train to the other. It is further necessary that the connections to be set up for putting the cars in electrical communication with each other shall be as few as possible, and that they shall operate rapidly, simply, and by means of strong parts. Engineers, in fact, meet with a certain difficulty, that of getting employes, in making a coupling, to effect the union of a certain number of distinct connections. Such a difficulty was even considered almost absolute a few years ago, but the constantly extending use of continuous brakes has caused it to be surmounted; for employes having now become accustomed to make a connection between the different pipes in coupling the cars, do not neglect the joining of the electric cables. However, it is none the less necessary to reduce this operation to a minimum as regards time and complication.

Finally, a special mode of operation has been sought—a system of communication which may of itself signal a parting of the train. This, in the beginning, was indeed one of the

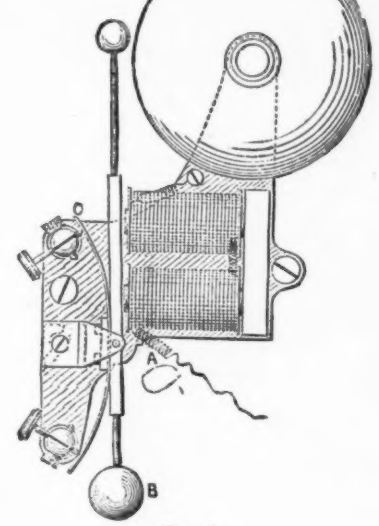


Fig. 3.

principal objects sought. A few years ago, if the rear cars became detached, those in the forward part of the train had no direct means of being made aware of it. This office it was desired that electricity should perform automatically.

The way in which the Tesse & Prudhomme system satisfied such conditions may be described as follows:

The system includes the use of two distinct and equal piles, each one of them being located in one of the two baggage cars. Each of these piles, consisting of six Leclanché elements, is placed in a special box, which contains at the same time the alarm-bells. The circuit consists of two complete cables, one of them insulated and the other

Fig. 4

connected with the earth. This latter might doubtless be done away with, as a simple communication with the earth would suffice; but, in the first place, on cars, communications of this kind made at a single point are not certain, and, in the second place, such a cable is necessary for automatism.

The two piles are arranged in opposition, that is to say, they are connected by their poles of like name. In a normal condition, these piles being equal, there is no perceptible current; but, if any two points whatever of the two cables be united metallically, a derived current is created, the two piles immediately begin to operate, each half of the circuit is traversed by a current, and the two alarms at once make themselves heard.

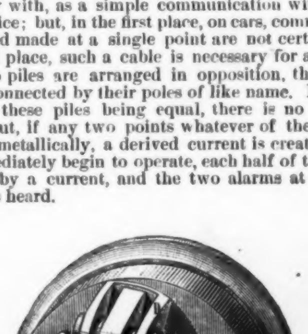


Fig. 5.

It would be just the same if, the train happening to part, the two broken ends of the insulated and earth cables were reunited. There would then be a complete circuit for the pile, and the signals would be given. This is just what takes place in the case of an uncoupling of the train, and it occurs as a consequence of the very arrangement of the coupling hooks. These latter constitute one of the interesting features of the system. Each hook, as shown in Fig. 1, is provided with a fixed base and a movable bar, B, which is drawn against the base by a stiff spring. The conducting cable, which runs under the frame of the car, is prolonged by a flexible conducting cord terminating in a bronze ring, C. For coupling, the ring is inserted between the movable bar of the hook and the frame, which are thus kept separated. Contact is thus insured. In case the train should part through accident, or in case that, on uncoupling of the cars, there should be a neglect to unhook the cable, no trouble would occur; for the cable, being pulled back, would open the hook, which would fall back on its base and destroy the connection. Under such circumstances a peculiar arrangement comes in play. The bar of the hook, drawn by its spring, cannot reach the frame, but abuts against the projecting head of a bolt, A, that is shown in the figure. Now the hook and its base belong to the insulated cable, but the bolt is connected with the ground cable, so that the contact of the hook with the bolt, whose head is a conductor, establishes a communication between the pile and the earth, completes the circuit, and causes the alarms to operate. It

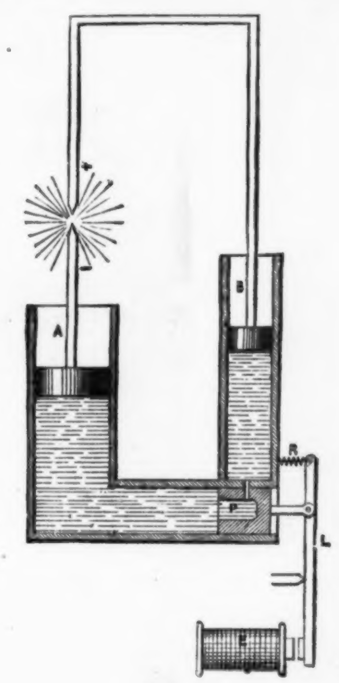


Fig. 6.

is through such an arrangement that the apparatus is automatic.

Each of the compartments of the cars has two wires that lead to the two cables, and if these are united a derived current is created, and a signal given. This reunion is effected by giving a contact in a manner in which there is nothing peculiar; but as regards the alarm-bells there is a somewhat special arrangement to which attention must be called. If these were constructed in the usual manner the jarring of the car would cause them to ring almost continuously. To prevent this the armature which carries the hammer abuts against a small stop which is raised by the electro-magnet when the latter begins its operation. The hammer having become free can then perform its usual role.

This system has been in use on the Railway of the North for quite a long time. As may be seen, it answers the

Fig. 7.

requisite conditions, is simple, and presents important advantages. It is, however, not without its defects, the principal of these being that the contacts in the hooks are not absolutely secure. And then, again, dust and, what is more dangerous, soot, introduce themselves between the ring and the hook, or cover the head of the bolt so that the apparatus cannot work. This defect was sufficiently great to cause the Railway of the West, which had the system on trial, to give it up. It may well be asked, however, whether the experiments in this case were sufficiently prolonged.

The Paris-Lyons Mediterranean Company, which has applied the system, has modified the hook by substituting for it a sort of box with bayonet catch, the movable bottom of which is pressed against by a spring. The flexible cable ends in a projecting plate, which is thus strongly pressed against the bottom of the box. This arrangement naturally gives surer contacts, since these are completely inclosed and protected from external influences; but two advantages of

the Prudhomme hook are thus lost. On the one hand, if the train should separate while the cables were in position, either these or the joint would break, and on the other hand, there is no longer here any automatism, that is to say, if the train should part, the alarm-bell would give no warning of it.

The first defect is an unfortunate one, but the second has lost its importance since continuous brakes have come into use. These latter, as well known, are automatic, and stop the train of themselves as soon as an accident of the above nature supervenes. It is no longer necessary, then, to have it signalized in any other way.

cept by a peculiar maneuver, so that the employes may always know whence the signal emanated.

Finally, special manipulators (Fig. 5) are placed in the baggage-cars. The key, B, may be used for sending interrupted signals, as with the Morse telegraph, or for entirely closing the circuit and giving an alarm signal, by causing the bell to ring continuously. The latter object is effected by turning the key towards the point, C, of its contact.

These arrangements, which have been studied out under the direction of Mr. Regray, engineer in-chief of the Company of the East, are still somewhat new; and it is not at present possible to give a correct judgment in regard to

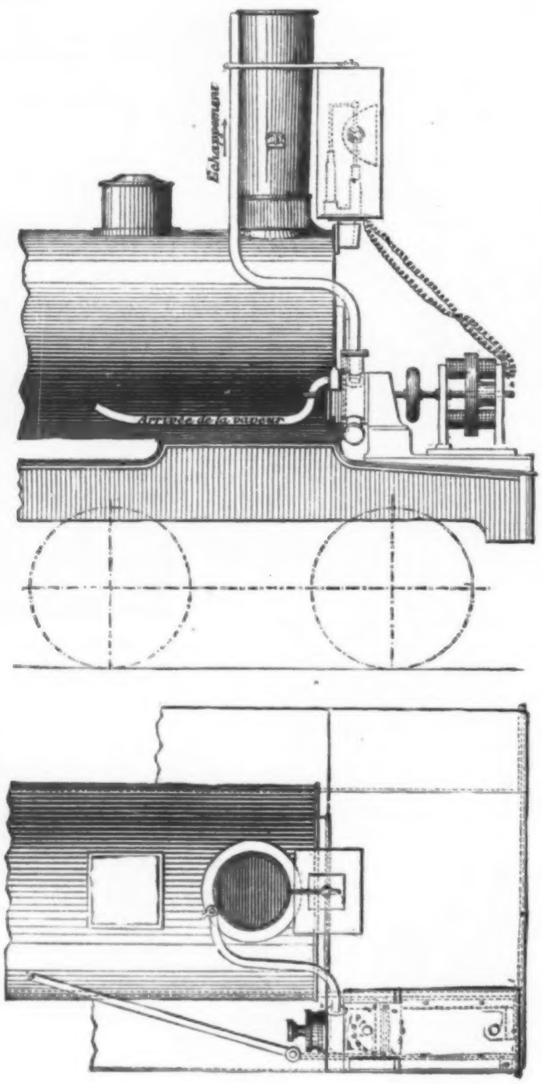


FIG 8.

The Railway Company of the East has recently taken up this subject and devised a series of new arrangements that are quite interesting. The general arrangement of the circuits is the same as in the Tesse & Prudhomme system, two equal piles being placed in opposition, but being of slightly smaller size. There are also two cables, but there is no earth connection. The coupling apparatus between the cars is shown in Fig. 2. The hook consists of two copper jaws, the lower of which, E, is stationary, while the upper one, C, is pressed against the other by a stiff spring. The ring attached to the end of the cable terminates in a straight bar, A. This is pushed in between the two jaws, which separate and allow it to fit naturally into a notch, where it is firmly held by the pressure of the spring, thus giving a very sure electric contact, and one that is protected against dust. It will be remarked that the two lateral sides of the ring are prolonged beyond the terminal bar and form a sort of fork. The purpose of this arrangement is to insure of the escape of the ring in case the cars become uncoupled. If such a thing were to occur, the cable would be drawn horizontally and tend to lift the sleeve of the ring, which, then revolving around the contact bar, would cause the two branches of the fork to rest against two lateral projections, D, so that the whole would form a lever, the upper jaw would be raised, and the ring would escape from its notch. There is thus avoided the trouble that has been pointed out in the coupling employed by the Paris-Lyons-Mediterranean Company, that is to say, the breakage of the cable in case of an accidental uncoupling of the cars. It is true that there is wanting here the advantage of an automatic closing of the circuit, as in the Prudhomme hook; but, as has been above remarked, this feature has become of no account since the use of continuous brakes has been introduced.

The alarm-bell has likewise been simplified. To prevent it from jingling through the jarring of the train in motion, the hammer has been simply suspended by its center of gravity at A (Fig. 3), the weight of the upper part being balanced by a metallic ball placed at B, and which may be raised or lowered by means of a screw thread. The spring is doubled in length, and forms at C a current interrupter, as in the ordinary arrangement. The button located in each car, and serving, when pulled, to give the alarm, has likewise been modified. On the Railway of the North, it is a ring, which is placed between two glass plates, in the partition separating the two compartments. On the Railway of the East, there is employed a box (Fig. 4), which is fixed to the ceiling of the car; and the signal is given by pulling a projecting button, B, thus causing the bottom of the box to revolve and forming a contact through an internal spring. Having once been pulled, the button cannot be replaced ex-

them. However, as they are based upon experience with other systems, their success may be relied upon.

Another recent application made of electricity on railways is for the production of light.

The difficulties to be overcome in such an application will be at once understood. It seems, in fact, that only incandescent lamps can be used on railway trains, it being impossible for regulators to operate on account of the jarring. This is really true of ordinary regulators; but the one that has been employed is perceptibly different from those that we are acquainted with, and has been used on locomotives for furnishing the head-light. The first trials of it were made by the inventors, in Germany, and the experiments were renewed last December on the Railway of the North, between Paris and Dammartin.

The lamp is on the Sedlaczek and Wikullil system, and is a liquid apparatus. The principle, as well known, is not new, but a very ingenious application is here made of it. A diagram of the apparatus is given in Fig. 6.

It consists, in principle, of two vertical tubes, A and B, of different diameters, which communicate with each other at the bottom; which are filled with glycerine; and into which are inserted two pistons carrying the carbons.

At the lower part of the tube, B, there is a small hollow piston, P, which is connected with a lever, L, and kept in the position shown by means of a spring, R, that may be regulated at pleasure.

At its other extremity the lever, L, terminates in an armature which is placed in front of an electro magnet of slight resistance, E, into which is constantly passing the current which supplies the lamp.

It will be seen that, in the position shown in the figure, the two tubes, A and B, communicate through the intermedium of a small aperture in the piston, P. The result of this is that the pistons assume a position of equilibrium that may be so regulated that, when at rest, the two carbons shall be in contact.

As soon as the current passes, the resistance of the arc being null, the electro-magnet, E, becomes strongly magnetized and attracts the lever, L. The little piston, P, moves from left to right, and closes the communication between the tubes, A and B, while at the same time it causes the level of the liquid to lower a little in the tube, A, and consequently depresses the lower carbon. The voltaic arc is then formed; and, from that moment, the piston, P, acts as a regulator, and sets up or cuts off communication between the tubes, A and B, that is to say, it causes the carbons to approach or recede from each other according as the resistance of the arc increases or diminishes.

The actual form of this apparatus is given in Fig. 7, where we find the essential parts that are indicated in the diagram; here, however, as will be noticed, the electro-magnet that acts upon the regulating piston occupies a lateral position, thus giving the whole affair a more compact arrangement. Yet this form is not its final one, for Messrs. Sautter & Lemonnier, its present manufacturers, are now studying out a new arrangement.

For lighting this lamp, Messrs. Sedlazcek & Wikullil use the Schuckert machine, which, being well known to our readers, need not be described. In the arrangement adopted, the machine is directly connected with a small Brotherhood motor. In Germany, the entire apparatus was placed on the top of the locomotive boiler; but, in the experiments on the Railway of the North, it was placed on the fore-carriage of the engine, as shown in Fig. 8. It was fortunate that this railway possessed engines of this type; for the experiment, which had to be made hastily, was greatly facilitated thereby; and, moreover, the general aspect of the whole was more satisfactory (Fig. 9).

The results have been found very good. The lamp is steady and brilliant, and permits of distinguishing edifices and bridges to a distance of 400 or 500 meters. The visibility of signals is not altered, and a train thus signaled can be seen at a distance of more than 1,500 meters. The aspect of a train thus lighted is given in Fig. 10.

However, it seems that the management is not very eager to adopt the system—different objections being made to it. The first of these, and doubtless the most serious, is the expense. Each apparatus is reckoned at about 3 0 0 francs; and for making the installations on the Railway of the North it would cost about four millions. Moreover, the annual expense of the supply of electricity would increase this, according to calculations, by 650,000 francs. This is a large sum, and it may well be conceived why it should cause some reflection. Nevertheless, were the utility well ascertained there would be no reason to shrink from employing it. But this point is likewise under discussion.

It has been remarked that it is not necessary that the train should see far ahead, for it is not the train that has to avoid obstacles, since these should not get in its way; but it is profitable rather that the train should be visible from a distance, inasmuch as when at a standstill, it forms, itself, the most dangerous kind of an obstacle.

For this reason, the lamp would be better placed on the rear than on the front of the train, since the protecting power of the electric signal is incomparably greater when it is located on the obstacle itself. But under these circumstances the installation and the supply of the lamp present many difficulties.

To sum up, it seems that, in the opinion of engineers, there is a utility in this use of the electric light, but one which is out of proportion to the expense. It is estimated, however, that these apparatus might find an excellent application in cases of urgent night-work, on the occasion of an accident, for instance. In such a case, a wrecking train provided with this powerful mode of lighting would prove eminently valuable. Fig. 12 shows the value of the electric light in the case of an accidental land-slide across the track of an approaching train.

FIG. 9.—LOCOMOTIVE PROVIDED WITH ELECTRIC LIGHT APPARATUS.

The electric light has also been applied in another direction, and that is for the complete lighting of the cars themselves. Trials of this nature have already been made in England, and an entire train has been lighted with accumulators on the Faure system. The number of incandescent lamps employed was 11, the duration of the lighting was 5 hours, and, according to certain papers, the number of elements was 25. These figures are acceptable. A much completer experiment, and a much better conceived one was made on the Railway of the East, on the 9th of last March.

The train carried all the applications of electricity that have thus far been put to use, such as the electrical intercommunications just described; the electric brake on the Achard system, improved by the company's engineers; and the Maxim lamp for lighting the compartments.

Each of these applications of electricity had a separate generator; the intercommunications had their pile, the brake was actuated by a Gramme machine driven by a Brotherhood engine, and the lamps, 31 in number, received their current from a Gramme machine located in the baggage-car, and actuated by gearing connected with the axle of the car, and also from three series of 24 Meritens accumulators each, coupled for quantity. The necessity for such a combination may be easily conceived. The Gramme machine furnishes a current only when the train is going at full speed, and its action being annulled during stoppages or a slowing up, it is necessary that it be supplemented. This is the office that the accumulator is designed to fulfill. But just here exists a difficulty.

Although, theoretically, it seems a simple matter to charge an accumulator with a machine, practically it is a very delicate one, especially if the operation of the machine is unequal. In such a case it happens that, instead of discharging itself into the effective circuit, the accumulator has a tendency toward the machine, if the electromotive force of the latter falls below that of the accumulator.

This leads to troubles of all kinds, such as a weakening of the lamps, an injurious effect exerted on the machine, a rapid loss of the accumulated electricity, and a heating of the wire. It is absolutely necessary, then, to interpose between the machine and the accumulator some device that shall bring about automatically a disjunction of the two apparatus at the proper moment. As well known, there are already some apparatus of this kind. One of them was devised by Mr. Tommasi, and consists essentially of an electro-magnet whose armature causes a contact between the machine and accumulators. This magnet hangs from a small Deprez generating machine moved by a belt connected with the Gramme machine. When the velocity of the latter is sufficient the Deprez machine has to furnish a current capable of actuating the electro-magnet, so as to make a contact between the parts; but below such velocity there occurs a rupture of the current.

As regards the yield of the Gramme machine with the Brotherhood engine, it was ascertained to be insufficient to light the 31 lamps of the train consisting of 13 cars. As may be seen, this was a good type of an ordinary train. On the contrary, this same machine gave excellent results when actuated by the axles of the cars when under full headway. On the return trip, the substitution of accumulators for the machine during stoppages was effected by hand, and the result found to be satisfactory. This experiment is by far the most extensive one that has been made. In the analogous trials in Germany, nine lamps were the most that were used—seven in the compartments for travelers, and two in the baggage-cars. The result of it all is that the problem has been found capable of solution. Studies over it are still being kept up, and we shall before long return to the subject to announce the final experiment, and give the details in regard to the regular lighting of a train by electricity. But will everything have been achieved on that day? Doubtless not; for there will still remain quite numerous improvements to be worked out. For, instance, in the present state of things, it would be impossible to disconnect the train; for the cars, on being separated from the locomotive, would cease to be lighted. This is a difficulty that must evidently be surmounted.

Moreover, the *materiel*, as it now exists, is too complicated; for two machines, accumulators, piles, and three distinct double conductors are inadmissible. One generator, with the aid, if necessary, of accumulators, ought to be enough. One conductor (or two at the most, connected by one hook—there is no need of more) should suffice; and there is a possibility that the other parts of the electric service may be united by this same coupling. We do not say that this is easy to do, for, on the contrary, we are convinced that the matter is a subject for much labor on and for many efforts. But it is sufficient to know that it is possible, to assure ourselves that it will be done.—*Journal Universel d'Electricité.*

FIG. 10.—TRACK LIGHTED BY AN ELECTRIC HEAD-LIGHT.

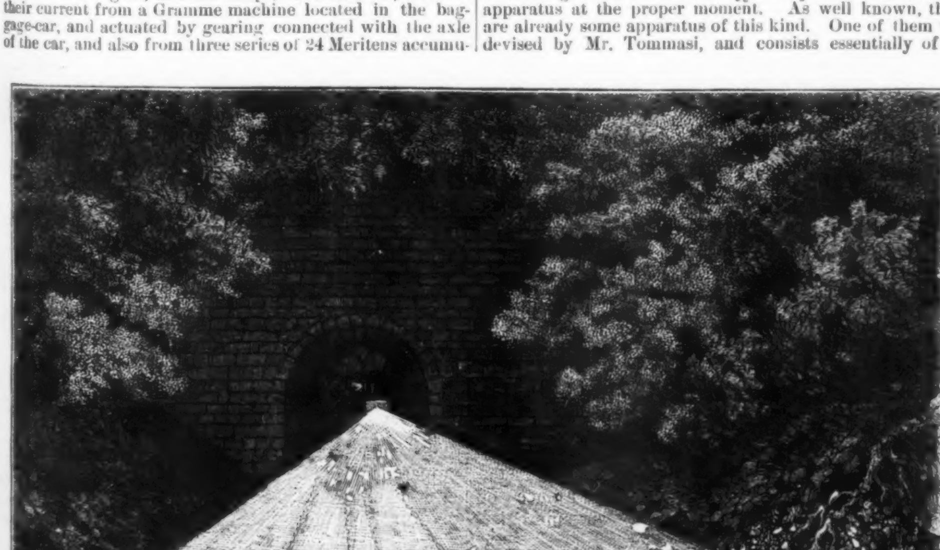


FIG. 11.—PRESENCE OF OBSTACLES ON THE TRACK SHOWN BY ELECTRIC HEAD-LIGHT.

THE "SUN" ELECTRIC LAMP.

A NEW departure in electric lighting has just been made public by the introduction of the "sun" electric lamp, in which the light is produced by a direct combination of the arc and incandescent systems in the same lamp. It is the invention of M. Louis Clerc, of Paris, and so far as a demonstration which was given on Saturday last showed, it certainly possesses special merits. The lamp consists of two carbon rods of D section, and about 6 in. in length, the lower ends being inserted at an angle of about 40° in a block of fire clay or other refractory material, and the upper ends being electrically connected with the current generator. At the point in the fireclay block where the lower ends of the two carbons approach each other a space is left in which is inserted a small block of white marble, upon which the carbons impinge. On the underside of this piece of marble is a small cavity having two perforations, by means of which the arc is first formed in the cavity. The marble, quickly becoming heated, forms the light-giving center, from

which radiates a particularly soft and agreeable incandescent light. The carbons being of large sectional area, their consumption is very slow, and is followed up simply by their own gravitation. There is, in fact, no mechanism whatever about the lamp, which is of very simple construction, the fireclay and marble blocks being merely held in a metal framing, which is suspended inside a glass globe. The carbons and the marble will last from thirty to forty hours without either of them requiring renewal. The light produced is exceedingly steady, and is devoid alike of the blueness and intensity of the arc light, and of the reddish yellowness of the incandescent lamp. At the recent demonstration which was given in the vaults beneath the Royal Exchange, London, there were four lamps shown, two being in one room, one in a second room, and another in the engine room. Each lamp was estimated to be of 1,400 candle power, and they were placed in glass globes of different kinds in order to judge of the effects of plain and opalescent glass. One of the lamps was inverted, the light being thrown upward upon a white ceiling and by this means was well diffused throughout the whole apartment. The current was produced from a Gramme self-exciting machine, capable of working six lamps, and which was driven by a 12-horse power Otto gas engine. The dynamo machine was working in two circuits. On the whole, the light produced was very satisfactory.

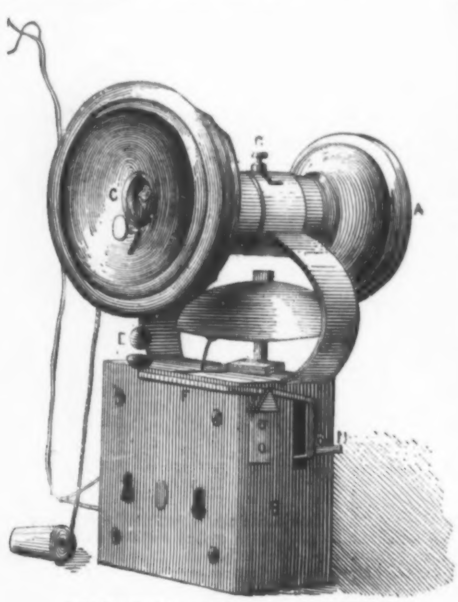
A VIBRATING-BELL TELEPHONE SIGNAL.

Colonel Jacobi exhibited, at the close of last year, to the Society of Physics, a telephone call in which the bell was set free by the very motions of the diaphragm.

The annexed figure shows how the apparatus is constructed.

Beneath a telephone, A, of the Siemens system, there is adapted a spring bell arrangement, operating in such a way that when the lever, C, is depressed the bell rings, and when it again assumes its position of equilibrium the ringing ceases. The mouth-piece of the telephone is provided with a groove in the middle which serves as a point of suspension for a small plate, E, carrying at its extremity an insignificant weight.

When the diaphragm vibrates strongly, its vibrations cause the fall of the plate, E, which acts upon the lever, C, and sets the bell free. The latter then continues to ring as long as the lever, C, remains down.



VIBRATING TELEPHONE SIGNAL.

The vibrations necessary to effect the ungearing of the bell are produced at the transmitting station by means of an ordinary Siemens whistle. When the two persons who wish to converse have exchanged their call signals, they each lock their levers by means of the rod, F, lower their plates, E, and begin their conversation. The talk finished, each one puts his apparatus in its former position.

Col. Jacobi points out the fact that the fall of the plate, B, may be employed for closing the circuit of an electric bell connected with a local pile.

As may be seen, this apparatus is based upon the same principle as the Ader signal.

THE DIFFERENTIAL STAINING OF NUCLEATED BLOOD CORPUSCLES.

By Allen Y. Moore, M.D.

It has been urged against the differential staining of histological structures, that the process may induce an alteration which may be mistaken for the normal condition. That this is, in many cases, true, is beyond question, but the exceptions are far too numerous to justify it as a rule.

For some years past I have used a process for the double staining of nucleated blood corpuscles, which causes no alteration, except of course in color, and as the structure can be seen much better in a semi-transparent than in a more perfectly transparent body, the corpuscles thus stained, offer advantages for study which are not found in those left unstained.

The fluids used for this purpose are two, which I shall designate as A and B. Their formulas are as follows:

A.

Eosin	5 grains.
Distilled water	4 drachms.
Alcohol	4 drachms.

Dissolve the eosin in the water and add the alcohol.

B.

Methyl anilin green	5 grains.
Distilled water	1 ounce.

The blood should be spread upon the slide, by placing a drop upon one end and quickly drawing the smooth edge of another slide over it. This, if well done, will leave a single layer of corpuscles evenly spread over the central part of the slide.

When the corpuscles on the slide are thoroughly dry, which will only require a few minutes, the slide should be "flooded" with stain A.

This should be allowed to remain on for about three minutes, at the end of which time it may be washed by gently waving back and forth in a glass of clean water. Before it is allowed to dry, the corpuscles should again be flooded, this time with stain B. After two minutes exposure to this fluid, the slide should be washed as before and set away to dry. When dry, a drop of Canada balsam may be put upon the blood, a cover-glass applied, and the whole gently warmed until the balsam spreads out properly. When hard it may be finished the same as is usual with balsam mounts.

If now examined with the microscope, the corpuscles will be found to be well stained with red, while the nuclei and "leucocytes" will be a bluish green.

The granular appearance which is ordinarily seen in the nuclei now shows with a vigor and sharpness which is difficult of description, while the whole corpuscle is as brilliant as a newly cut ruby.

In regard to the structure of the corpuscles, I can say but little. I have never had any difficulty whatever in seeing a distinct granular appearance in the nucleus, provided a first-class objective was used. But so far as a network is concerned, I have completely failed to see anything that could be called such, except when the objective used was improperly adjusted for thickness of cover or immersion fluid. In such cases the dots or granules "appear to run into lines," and a reticular structure may be interpreted. Even by the use of boracic acid I have completely failed to "bring out" the network.

It has been held by some that the corpuscles are covered by, or inclosed within, a "limiting membrane," but those who have endeavored to substantiate their claims—upon either side of the question—have failed as yet.—*The Microscope.*

AN EXPERIMENTAL RESEARCH ON TUBERCULOSIS.

After a series of experiments on the true nature of tuberculosis and its products, Dr. C. Robinson has arrived at the following conclusions:

Tuberculosis artificially produced in animals is not due to a specific virus.

To produce tuberculosis in animals, inoculation with tubercular matter is not necessary.

Failures to produce tuberculosis by inoculation with substances other than tubercular, are in the same proportion as failures with true tubercular matter.

The introduction under the skin of any foreign substance capable of exciting an inflammation, or any traumatic injury, can produce tuberculosis, provided the animal is of scrofulous habits.

Scrofulosis in animals is expressed by an inflammation, terminating in the production of a cheesy mass.

Animals not generally scrofulous (cats and dogs) may become so, and then only tuberculosis can be produced in them.

Miliary tubercles are simply aggregations of cells of any simple, ill-nourished granulation tissue compressed into small nodes. The arrangement into nodes represents a true antemortem act of cells, to which any young inflammatory connective tissue is liable.

Under favorable conditions of nutrition, tubercles in animals may undergo a higher organization, becoming converted into small, harmless fibromata.

Tubercles artificially produced in animals are histologically strictly identical with those occurring in man.—*Philadelphia Medical Times.*

HOW SEAL-SKINS ARE DRESSED.

Mr. H. W. Elliott, in an excellent monograph of the Seal Islands of Alaska, recently published under the auspices of the U. S. Commission of Fish and Fisheries, gives the following information in regard to the manner in which the natural seal-skin is tanned, plucked, and dyed, so as to fit it to pass the ordeal of fashionable dress-parade. The operator who furnished him with the details says:

"When the skins are received by us in the salt, we wash off the salt, placing them upon a beam, somewhat like a tanner's beam, removing the fat from the flesh side with a beaming-knife, care being required that no cuts or uneven places are made in the pelt. The skins are next washed in water and placed upon the beam with the fur up, and the grease and water removed by the knife. The skins are then dried by moderate heat, being tacked out on frames to keep them smooth. After being fully dried, they are soaked in water and thoroughly cleansed with soap and water. In some cases they can be unhaired without this drying process, and cleansed before drying. After the cleansing process they pass to the picker, who dries the fur by stove-heat, the pelt being kept moist. When the fur is dry he places the skin on a beam, and while it is warm he removes the main coat of hair with a dull shoe-knife, grasping the hair with his thumb and knife, the thumb being protected by a rubber cob. The hair must be pulled out, not broken. After a portion is removed the skin must be again warmed at the stove, the pelt being kept moist. When the outer hairs have been mostly removed, he uses a beaming-knife to work out the finer hairs (which are shorter), and the remaining coarser hairs. It will be seen that great care must be used, as the skin is in that soft state that too much pressure of the knife would take the fur also; indeed, bare spots are made. Carelessly-cured skins are sometimes worthless on this account. The skins are next dried, afterward dampened on the pelt side, and shaved to a fine, even surface. They are then stretched, worked, and dried; afterward softened in a fulling-mill, or by treading them with the bare feet in a hogshead, one head being removed and the cask placed nearly upright, into which the workman gets with a few skins and some fine, hardwood sawdust, to absorb the grease while he dances upon them to break them into leather. If the skins have been shaved thin, as required when finished, any defective spots or holes must now be mended, the skin smoothed and pasted with paper on the pelt side, or two pasted together to protect the pelt in dyeing. The usual process in the United States is to leave the pelt sufficiently thick to protect them without pasting.

"In dyeing, the liquid dye is put on with a brush, carefully covering the points of the standing fur. After lying folded, with the points touching each other, for some little time, the skins are hung up and dried. The dry dye is then removed, another coat applied, dried, and removed, and so on until the required shade is obtained. One or two of these coats of dye are put on much heavier and pressed down to the roots of the fur, making what is called the ground. From eight to twelve coats are required to produce a good color. The skins are then washed clean, the fur dried, the pelt moist. They are shaved down to the required thickness, dried, working them some while drying, then softened in a hogshead, and sometimes run in a revolving cylinder with fine sawdust to clean them. The English process does not have the washing after dyeing.

"I should, perhaps, say that, with all the care used, many skins are greatly injured in the working. Quite a quantity of English dyed seal-skins were sold last season for $17, damaged in the dye.

"The above is a general process, but we are obliged to vary for different skins. Those from various parts of the world require different treatment; and there is quite a difference in the skins from the seal-islands of our country—I sometimes think about as much as in the human race."

Mr. Elliott remarks that the common or popular notion in regard to seal-skins is that they are worn by those animals just as they appear when offered for sale; that the fur-seal swims about, exposing the same soft coat with which our ladies of fashion so delight to cover their tender forms during winter. Such is not the case, however, for few skins are less attractive than that of the seal when taken from the animal. The fur is not visible, but is entirely concealed by a coat of stiff overhair, dull, gray-brown, and frizzled. It takes three of them to make a lady's sacque or boa, and this, coupled with the tedious and skillful labor necessary to their dressing, as above described, will serve to show the reason for their costliness.

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